PRODUCT ENGINEERING

FEBRUARY 1959

PRECISION INVESTMENT CASTING

IN THIS ISSUE—Design Practice for Investment Castings + Measurement of Angular Acceleration + Carbon-Graphite Parts + New Hydraulic Standards + Time Controls

A McGRAW-HILL PUBLICATION

Nickel Cast Iron helps Elmes...

MASTER HIGH STRESSES IN HYDRAULIC PRESSES

Extra strength, pressure-tightness and wear-resistance characterize major castings in this "Hydrolair" press . . .

Moreover, these properties may be secured whenever needed in cast parts by producing them in nickel alloy irons.

To meet a tensile strength specification of 50,000 p.s.i. minimum, Lindgren Foundry Company, Batavia, Ill., casts heads, cylinder bases, platens and intensifiers for "Hydrolairs," of a composition including 1.50% nickel and 0.50% chromium.

Along with essential strength, this type of nickel-chromium cast iron provides a dense, close-grained structure that remains free from leaks or pressure losses even though hydraulic stresses run high.

Write for our recommendations regarding the best nickel alloyed irons or steels for your applications.

Elmes Engineering Works of American Steel Foundries, Chicago, Ill., build "Hydrolairs" to provide small-press users with equipment for fast, economical operation. Floor and bench type models of 20, 30 and 50 ton capacity are available.

EMBLEM OF INCO SERVICE

Over the years, International Nickel has accumulated a fund of useful information on the properties, treatment, fabrication and performance of engineering alloy steels, stainless steels, cast irons, brasses, bronzes, nickel silver, cupro-nickel and other alloys containing nickel. This information is yours for the asking. Write for "List A" of available publications.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

VOLUME 19 **PRODUCT ENGINEERING** NUMBER 2

G. F. NORDENHOLT, *Editor*
Assistant to the Editor, Joseph Kerr • *Managing Editor*, James R. Bright • *Associate Editors*, Harold Schor, V. H. Laughner • *Assistant Editors*, E. S. Cobb, J. D. Cooney, R. Campbell, N. J. Van Ness
Consulting Editor, Robert E. Bruckner • *Washington*, George E. Doying, Jr.
Publisher, Albert Hauptli • *Assistant Publisher*, W. E. Kennedy
Foreign News Bureau: London • Paris • Berlin • Moscow • Tokyo • Bombay • Melbourne • Rio de Janeiro • Buenos Aires.

FEBRUARY 1949

Carbon-Graphite Pressings by Fremont F. Ruhl 81
Information and data for the design of bearings, seals, pistons and numerous other parts.

Instrument for Measurement of Angular Accelerations by D. E. Weiss 86
Construction of an angular accelerometer and the theory underlying the design of the instrument.

Product Designs 90
Fatigue tester, Centrifuge for speeds to 70,000 rpm, 1949 Buick. Remote control manipulator.

Design of Precision Cast Parts by J. F. Henderson 100
Simple design rules that reduce the cost of precision cast parts.

Copper-Base Alloys for Springs—I by Harold C. R. Carlson 103
General and specific design data including corrosion resistance properties and workability.

Silicone Fluids in Hydraulics and Lubrication by T. A. Kauppi and C. C. Currie 108
Methyl silicone fluids in damping, hydraulic, lubricating and dielectric applications.

Hydraulic Standards for Industrial Equipment 113
The complete standards as prepared by the Joint Industry Conference.

Industrial Time Controls—Nomenclature and Standard Types by R. H. Mecklenborg 125
Reset and non-reset features, means of adjustment, inclosures and general construction arrangements.

Housings and Mountings for Ball and Roller Bearings 130
Various methods for supporting rolling-contact bearings in machinery.

The Cathode-Ray Oscillograph as a Design Tool 132
Versatile instrument simplifies the study of transient phenomena occurring in high speed machinery.

Thermosetting Plastic Laminates—II by Norman A. Skow 138
Physical, chemical and electrical properties, and applications of the various grades.

Radial Stresses in Linearly Tapered Turbine Blades by Joseph R. Bressman 155
Charts for simple determination of stresses caused by direct centrifugal loading.

DEPARTMENTS

FRONT COVER—A precision investment casting, from blueprint to finished part. Kodachrome courtesy of the Allis-Chalmers Mfg. Company.

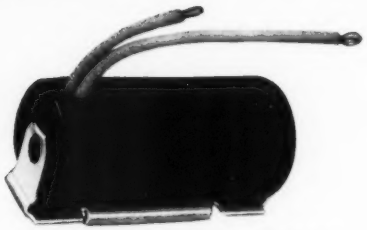
Highlights 3
Editorial 79
Engineering Abstracts 144
Technical News 148
Washington Notes 151
New Materials and Parts. 161
New Books 174
Our Readers Say 188

Publication Office: 99-129 North Broadway, Albany 1, N. Y. Return postage guaranteed.
Published Monthly by McGraw-Hill Publishing Company, Inc. James H. McGraw (1860-1948), Founder; James H. McGraw, Jr., President; Curtis W. McGraw, Vice-President and Treasurer; Eugene Duffield, Executive Assistant for Publications; Nelson Bond, Director of Advertising; Joseph A. Gerardi, Secretary; J. E. Blackburn, Jr., Director of Circulation.
Correspondence About Subscriptions should be addressed to Director of Circulation, Product Engineering, 330 W. 42nd St., New York 18. Allow at least 10 days for change of address. Indicate position and company connection on all subscription orders.
Subscription Rates: Single copies 75¢, United States and possessions, $6 for one year, $9 for two years, $12 for three years; Canada, $7 for one year, $11 for two years, $14 for three years; Latin American countries, $10 for one year, $16 for two years, $20 for three years; all other countries, $15 for one year, $25 for two years, $30 for three years.
Editorial and Executive Offices: 330 W. 42nd St., New York 18, N. Y. Cable Address: "McGraw-Hill, New York."
Branch Offices: ATLANTA, R. M. Maultsby, 1011 Rhodes-Haverty Bldg.; BOSTON, John H. Koch, M. A. Williamson, Jr., 1427 Statler Bldg.; CHICAGO, Ray Deen, Anson E. Mesmor, 520 N. Michigan Ave.; CINCINNATI, R. H. Anderson, 1110 Delta Ave.; CLEVELAND, A. F. Tischer and R. H. Anderson, 1510 Hanna Bldg.; DETROIT, G. F. Weetherby, 2089 Penobscot Bldg.; LOS ANGELES, C. W. Dysinger, 622 S. Hope St.; NEW YORK, J. A. McGraw, Hugh Britton, 330 W. 42nd St.; PHILADELPHIA, David G. Jones, Architects Bldg., 17th and Sansom Sts.; PITTSBURGH, 738-9 Oliver Bldg.; ST. LOUIS, Continental Bldg.; SAN FRANCISCO, J. W. Otterson, 68 Post St.; WASHINGTON, National Press Bldg.; LONDON, Aldwych House, Aldwych, W. C. 2, England.

Entered as second-class matter Aug. 21, 1936, at Post Office, Albany, N. Y., under act of Mar. 3, 1879. Printed in U.S.A. Members of A.B.P., A.B.C. Copyright 1949 by McGraw-Hill Publishing Co., Inc. All rights reserved

Now Mount . . . Mallory Capacitors *On or Off the Motor*

ON MOTOR MOUNTING



OFF MOTOR MOUNTING

Pictures, drawings, electrical characteristics, data on mounting brackets — everything you want to know about Mallory AC Motor Starting Capacitors.

Mallory AC Motor Starting Capacitors in plastic containers have become the standard of capacitor excellence.

The improved mounting brackets for the new capacitors simplify ease of installation and cut assembly time. Capacitors may be mounted either *on* or *off* the motor. End caps are provided to simplify this operation: Type PL for "on the motor" mounting. Type PLA for "off the motor" mounting.

When desired, Mallory plastic capacitors may be mounted by any means now employed for ordinary capacitors of equivalent size.

For further mechanical and electrical data, ask for Form #746-F.

P. R. MALLORY & CO. Inc.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

SERVING INDUSTRY WITH

Capacitors — Rectifiers
Contacts — Switches
Controls — Vibrators
Power Supplies
Resistance Welding Materials

Highlights

In this summary of technical developments, space restrictions do not allow giving complete details. Further information relating to any item can be obtained by writing to the Editor of Product Engineering.

METALLIC MATERIALS

FERROMAGNETIC MATERIALS for use in compact communications equipment at frequencies from audio range to about 600 kc have high permeability and specific resistivity. Called Ferroxcube 3, materials are a homogeneous mixture of iron oxide and oxides of various bivalent metals including Zn, Ni and Mn. Limited quantities are available in the form of cylinders measuring 1 3/4 in. OD by 1 3/8 in. ID by 5/8 inch.

AIRCRAFT FUELS made of powdered aluminum or other metals could probably double or quadruple bomb-carrying range of military planes. NACA researchers are investigating these materials believed capable of being 2½ times as effective as equivalent amounts of gasoline.

A FREE-MACHINING ALLOY STEEL has hardness comparable to that of SAE 4150. Known as Rycut, material permits savings of 25 to 50 percent in machining time, and, in so doing, boosts tool life and reduces grinding time after hardening.

CHROME-SURFACED BALL BEARINGS made of SAE 52100 are not subject to seizure and oxidation in non-lubricated assemblies. Surface has greater density than electroplated chromium and can be applied in thicknesses down to 0.00002 in. Vapor degreasing is only pretreatment needed.

LOW TEMPERATURE STRAIN TESTS show 18-8 chrome-nickel steels undergo increase in strength during austenitic-to-ferritic phase change. National Bureau of Standards tests show reversal of stress-strain curve at - 78 C, while at -198 C, a second ultimate stress point is reached.

POWDERED HIGH-TEMPERATURE PHOSPHORUS on the inner glass wall of mercury vapor lamps makes the light eight times richer in red than that from tubes of clear glass. Fluorescent coating converts ultraviolet rays into pure red light, which when added to bluish-white vapor light, makes people and objects appear in natural colors.

DIES, PUNCHES AND MOLD PARTS made of a new molybdenum steel remain accurate considerably longer than do those produced from standard alloys. Increased hardness and toughness account for the non-deforming properties. Tradename is "Red Streak."

NONMETALLIC MATERIALS

PEARLESCENT ACRYLIC SHEETING has been one of the first-choice materials of package and display designers. But its use was extremely limited because the sheeting could not be made less than a quarter of an inch thick. Now it is obtainable in thicknesses down to 0.1 inch.

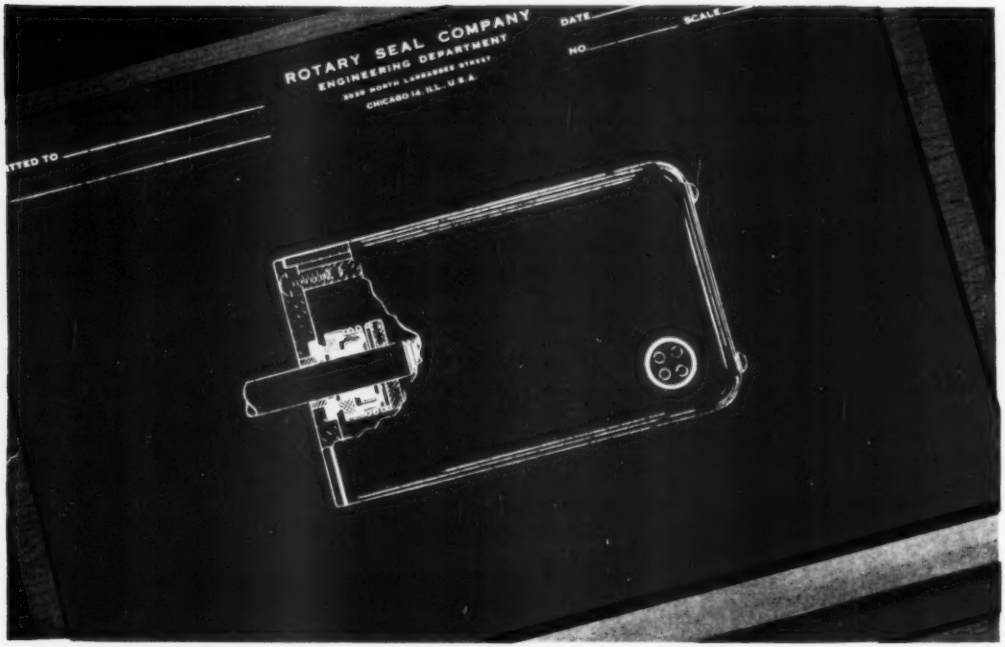
EXTRUDED RIGID VINYL STRIPS, 5 in. wide, in thickness ranging from 0.015 to 0.125 in. are replacing the acetate plastic in low pressure molded parts requiring clearly defined contours. Stable up to 170 F ambient, material is available in a range of colors that can be varied to match mating parts.

PLASTIC-BONDED LAMINATED PAPER, called Tensilite 300, costs only 25 to 35 cents per pound and is suitable for applications where precise dimensional accuracy need not be maintained and temperatures do not get above 160 Fahrenheit.

GR-S RUBBER when polymerized at low temperature, and hence called Cold GR-S, has 50 percent greater abrasion resistance and is less subject to flex-cracking and cut-growth when compared to the conventional GR-S. No improvement in the hysteresis, heat build-up, atmospheric cracking and cold stiffening properties has been noted.

Continued on Page 5

IT TAKES A SURE HAND TO TURN THE ODD TRICK—



but ROTARY SEAL experience means *Certainty!*

Shaft sealing problems can be highly critical—such as the one illustrated, involving a remarkably ingenious adaptation of the famous ROTARY SEAL principle to insure unvarying performance in very delicate radio equipment under a wide range of difficult conditions. Such problems are tricky. Solving them takes the practiced hand of a specialist, working from the background of vast practical experience accumulated by a pioneer in the field.

The sure hands of ROTARY SEAL engineers—thoroughly schooled in every aspect of shaft sealing through years of working with the makers of all kinds of equipment and devices in every field you can think of—can turn the odd trick, if necessary, for *your* special requirement. For best results all along the line, call ROTARY SEAL in at the drawing-board stage when planning new equipment in which *sure* shaft sealing is a factor.

THE ROTARY SEAL PRINCIPLE

is the original approach to a practical solution of a universally troublesome problem. Our booklet "Sealing with Certainty" explains and illustrates the principle. We're glad to send it to you without obligation.

THE ROTARY SEAL COMPANY
mechanical seals for rotating shafts

SEND FOR YOUR COPY TODAY ⇨

2024 NORTH LARRABEE STREET
CHICAGO 14, ILLINOIS, U.S.A.

SURFACE CLEANING AND DRYING preparatory to painting is one of the big costs in applying paints. Not so if you use the new vinyl resin primer. Makes no difference if the surface is wet or dry, clean or rusty, or steel, aluminum or galvanized--just go ahead and apply the primer. Manufacturer says it is a good primer for ship bottoms but does not state whether it is put on with the ship in dry dock or by a diver when the ship is in the fitting-out basin.

GUIDES AND PUSHER ARMS on conveyor systems handling fancy soaps, perfumes and the like are being equipped with rubbing surfaces made of Teflon. Result--no more scratching of delicate, packaged articles.

HEAT AND OIL ruins most latex rubbers causing them to become weak and brittle. That is why every maker or user of radiator hose, insulating tapes, gaskets, belting, or oil seals will be interested in the new latex compound that withstands temperatures up to 400 F, has tensile strength of 2,500 psi and stretches up to 10 times its original length.

COLOR PERMANENCE and corrosion resistance make phenolic panels highly desirable, but their relatively low strength and high cost have prevented extensive use. Now comes the answer--phenolic veneer on aluminum sheets--one side or both. Such decorative sandwiches can be formed to some extent without buckling or bowing. Can be had in any standard color plus black, and with wood graining. Decorative effects can be had by removing plastic skin to expose bright metal core.

POLECTRON is a plastic material chemically similar to polystyrene, has a heat distortion temperature about 100 deg better, namely 300 F, but is relatively brittle. It can be compression or injection molded. One big use is for impregnating the paper used in electric condensers.

FLEXIBLE VINYL FINISH will not crack when bent 180 deg around a 3/8 in. dia rod. No. 61S bonds directly to all metals and concrete, is unaffected by light, ultraviolet rays, dilute numeral acids and alkalis, nitric and chrome acids and salt spray. Produced in variety of colors, electrically non-conducting finish will cover 350 sq ft of surface per gallon when sprayed, 300 sq ft when brushed.

TWO NON-CORROSIVE PHENOLICS of the mineral-filled, granular type, are now in quantity production at Durez. The 77 Black material has a highly lustrous finish and low water absorption. The 75 Black sacrifices chemical resistance slightly to achieve improved molding properties.

PROCESSES

BRITISH PROCESS alloys steel surfaces with chrome thereby producing a surface that has the wear and corrosion resistance characteristics of stainless steel. Parts are heated to 1850 F in carburizing-type boxes packed with chromium-rich powder. Thickness of impregnated layer can be varied from 0.0005 to 0.025 in. according to carbon content of steel. Unit cost averages one-third that of stainless.

WATER PERMEABILITY of paint films can be determined by a photographic method. Sensitized paper is placed over wet surface to be checked and the combination put between metal places connected to a battery. Pressure and electrolytic action cause the emulsion to react, thereby showing areas where moisture has penetrated the paint film.

HEAT TREATING by the forced-convection heating method has been improved through the use of protective steam atmospheres in the furnace. Tool steels, cast iron, powdered iron compacts and non-ferrous alloys heated at temperatures up to 1150 F take on a clean, uniform, blue-oxide finish and have improved machinability, as well as higher corrosion and wear resistance.

AIR-CUSHIONED PLUNGERS and thermocouples facilitate measurement of piston temperatures while combustion engines are operating. Air pressure in the crankcase pushes plungers against terminals of thermocouples mounted in piston skirts. Wiping contacts with terminals complete circuit to potentiometer.

Continued on Page 7

Do you want LIGHT WEIGHT?

Hycar has it plus!

...AND THESE 8 OTHER ADVANTAGES!

1. Abrasion Resistance—50% greater than crude rubber.
2. Extreme Oil Resistance—insuring dimensional stability of parts.
3. High Temperature Resistance—up to 250° F. dry heat; up to 300° hot oil.
4. Minimum Cold Flow—even at elevated temperatures.
5. Low Temperature Flexibility—down to −65° F.
6. Age Resistance—exceptionally resistant to checking or cracking due to oxidation.
7. Hardness Range—compounds can be varied from extremely soft to bone hard.
8. Non-adherent to Metal—compounds will not adhere to metals even after prolonged contact under pressure. (Metal adhesions can be readily obtained when desired.)

For more information, write or ask your supplier to write B. F. Goodrich Chemical Company, Dept. HJ-2, Rose Building, Cleveland 15, Ohio.

Hycar
Reg. U.S. Pat. Off.
American Rubber

B. F. Goodrich Chemical Company

A DIVISION OF THE B. F. GOODRICH COMPANY

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers

CORROSION RESISTING CHROME COATINGS for hot-dipped, plated or die-cast zinc parts are produced by applying various dilute solutions of Unichrome Dip Compound 95. Finish is applicable to wire products, screws, hinges, automatic fuel pumps and carburetor bodies.

FACE PLATES are no longer the bottleneck in the production of television tubes. Standardized grinding and polishing is completed while the special glass is still flat. Forming to perfect sphericity without damage to the surface is then completed by a new bending process.

AN ELECTRONIC METHOD for sealing polyethylene films of thickness up to 0.004 in. "welds" buffer material in $\frac{1}{4}$ second. Heating is produced by a 200 megacycle current for which power setting and time of application are not critical.

EQUIPMENT

AIR JETS mounted in a ring check average dia of piston pins in automatic gaging machine. "Airlectric" heads actuate solenoids that open and close doors to sorting chutes. Machine handles 2,400 pins per hour.

SUPERSENSITIVE MONITORING INSTRUMENT can detect difference between 1,000,000 and 1,000,005 electrical impulses per sec. Used in communication work, equipment is first "package" unit that measures wave amplitude and power transmission as well as frequency.

NEUTRONS can now be detected and counted by a small instrument containing a film of U-235. The electrons radiated when neutrons bombard the uranium strike a photo-sensitive plate where they are multiplied, collected and counted.

AN X-RAY MICROSCOPE capable of 90 magnifications is at last a reality. As ordinary lenses will not refract these short-wave-length rays, two special crystals are used to create a cone of X-rays. Shadowgraph pictures like those produced in an electron microscope are the end result.

ABRASION TESTING SET rates wear resistance of all surface finishes, organic coatings and plastics by alternately rubbing two standardized "Calibrase" wheels over 4 in. specimens.

AUTOMATIC COAL MINING MACHINE substitutes one steady operation for the usual cutting, drilling, blasting and loading. Mounted on caterpillar treads and carrying a 45 deg swivel ripper bar, $22\frac{1}{2}$ ft machine can dig a ton of coal in 30 seconds.

"JETRONIC" OIL BURNER has special firing head that converts oil into jets of gas before combustion takes place. Adaptable for most types of small hot-air furnaces, steam and water boilers, burner reduces oil consumption by operating at high combustion efficiency.

MICROFILM CAMERA photographs copy such as drawings and blueprints of widths up to 42 in. in one continuous exposure. Unit also serves as printer and enlarger. Copy is moved through "Flofilm" camera at 30 or 60 fpm; five different degrees of light intensity can be selected by push-buttons.

MISCELLANEOUS

A SPRAY OF CRUSHED ICE has been proven an effective fire-extinguishing agent in Arctic regions. Stubborn gasoline-naptha-diesel oil fires have been brought under control by this method.

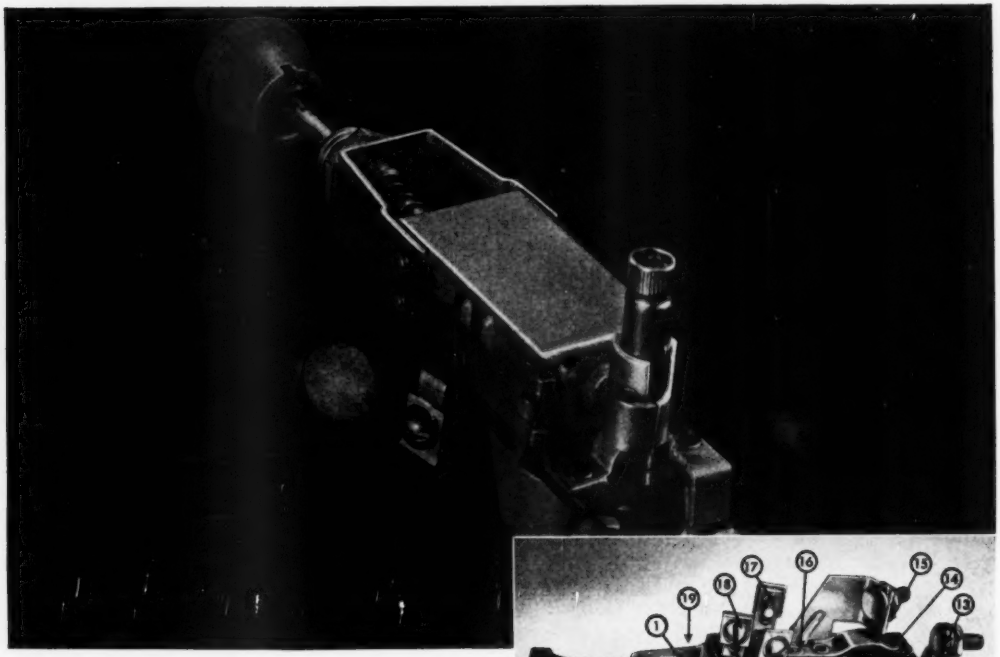
NEW TYPE AXMINISTER CARPET takes on that "hand-carved" effect through the blending of plastic with wool fibers. Plastic provides a low-pile background for the high-pile wool.

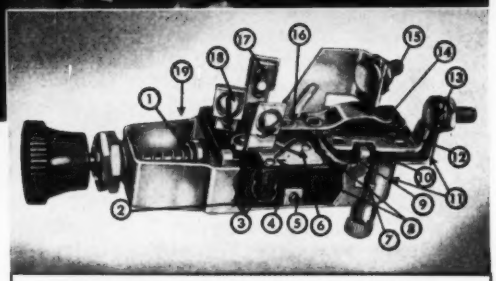
RADIANT-HEATED sections of a roadway near Detroit are under test this winter. Now controlled manually, temperature of road surface is eventually to be maintained at 35 F by automatic thermostats.

REPUBLIC'S F-84 THUNDERJET airplane has over 100 non-structural parts made of low pressure, reinforced molded laminates. Extra-hard plastics effect appreciable savings in overall weight and costs.

REVERE MATERIALS + COLE-HERSEE DESIGN ASSURE DEPENDABLE HEADLAMP OPERATION

(Sixty Percent of All Automobile Accidents Occur After Dark)





Three-Position Heavy Duty Headlamp Switch, made by Cole-Hersee Company, 20 Old Colony Ave., Boston 27, Mass.

1. Spring Backed Dustproofed Gland
2. Heavy Steel Case and Bracket
3. Four Separate Contact Springs
4. Moulded Bakelite Contact Carrier
5. Double Independent Action
*6. Heavy Gauge Phosphor Bronze Contactor
7. Interlocking Back Prevents Short Circuiting
*8. Silver Inlaid Phosphor Bronze Contacts
9. Canvas Base Bakelite
10. Six Clinching Ears
11. One Piece "Hot Wire" Conductor
12. Heavy Reinforcement and Thrust Stop
*13. Terminal Studs Welded to Conductors
*14. Heavy Gauge Phosphor Bronze Spring Contacts
15. Heavy Conductor and Thrust Stop
*16. Silver Inlaid Phosphor Bronze Contact Rivets
17. Heavy Gauge Screw Terminals
18. Shakeproof Lockwashers With Locking Tail
19. Bracket Extension To Clear Dash Obstructions

Parts starred are made of Revere Metals

HERE is a picture and sectional view of a device frequently used by motorists, who know nothing about it except that it has a knob and works perfectly when pushed or pulled. It is a Cole-Hersee three-position light switch: Off, Parking Lights, Headlights.

Because such a switch is so reliable and long-lived, one might suppose it to be simple. It is far from that. Its operation, however, is simple, and is protected by design and materials which foresee the conditions and contingencies of use.

• Note the variety of the materials. They include steel in several types and forms, brass, phosphor bronze, canvas base bakelite, a felt washer to exclude dust, plastic, and if you include the fuse, lead and glass. In the list of features the four items starred are made of Revere Metals.

This is an excellent example of the manner in which wise manufacturers employ Revere Metals. Both they and we realize that every metal and material has its individual qualities and applications. When these are understood and chosen with full regard for conditions of fabrication and use, a fine product has been given its fundamental guarantee. It is one of the important duties of Revere Technical Advisors to collaborate in the selection of the many different Revere Metals. If you would like to obtain the benefits of this service, get in touch with the nearest Revere Office.

REVERE

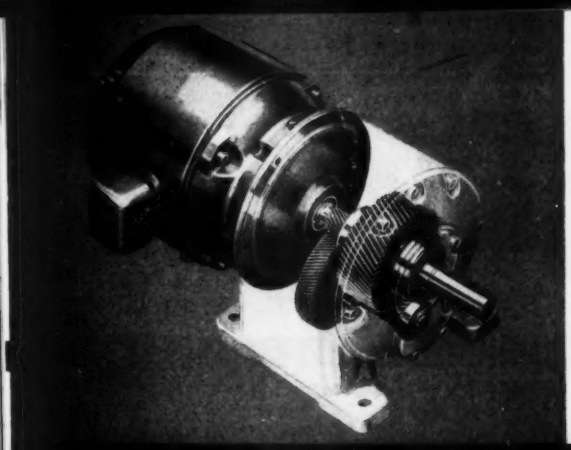
COPPER AND BRASS INCORPORATED

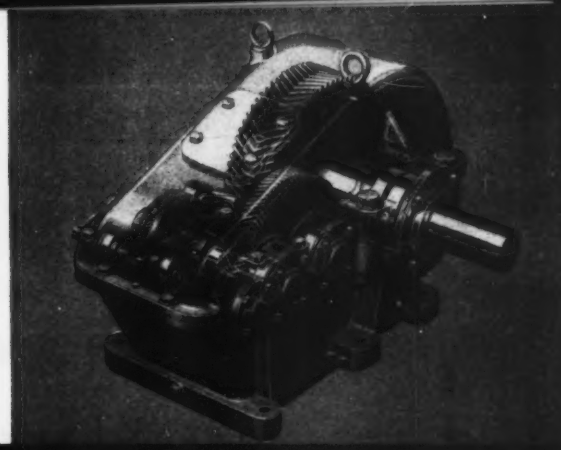
Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

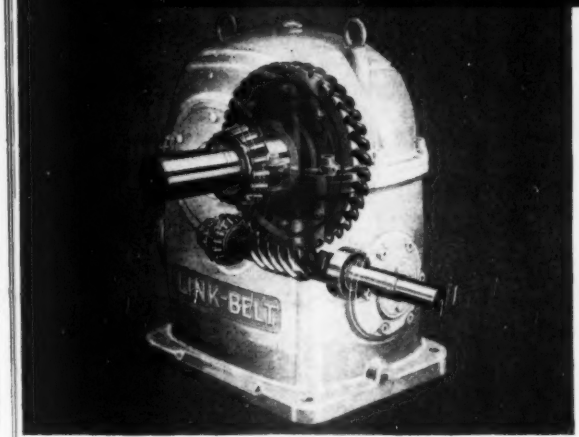
• • •

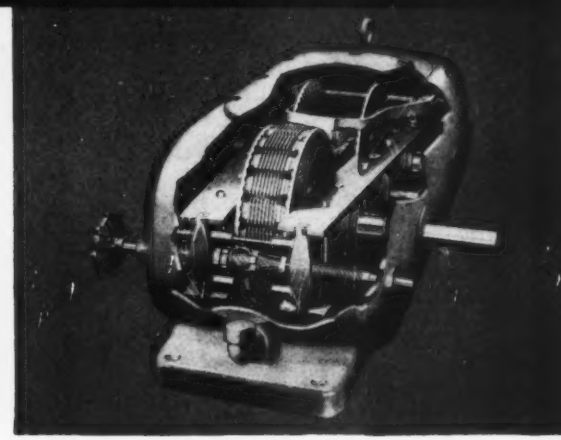
Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities, Distributors Everywhere.





is Speed Reduction Your Problem?





Consult Link-Belt!

Power at the required speed is available through the use of a Link-Belt enclosed gear drive. Regardless of your specific needs for ratio, power or speed, we have the correct answer, and our engineers will be pleased to assist you with your power transmission problems.

Gearmotors

Packaged Power Drives that are compact, economical and highly efficient are available with ratings from 1 to 30 horsepower and output speeds from 280 to 6 R.P.M. These easily-installed streamlined Gearmotors are completely explained in Book No. 1815, a copy of which is yours for the asking.

PIV Gear Speed Changers

In any process where precise speed is a factor in quality, costs, efficiency or profits, the PIV Gear is the ideal answer to your problem. Built with vertical or horizontal housing, plain or motorized, and with or without enclosed reduction gears. From ½ to 25 h.p. and ratios up to 6:1. Send for Book No. 1874-B.

Worm Gear Drives

For high reduction drive arrangements, these time-proved rugged drives are an ideal answer. Take your choice from a complete line of single, double or helical Worm Gear Drives having horizontal or vertical output shafts and satisfy exactly your requirements. We would be pleased to send Book No. 1824, which describes in detail our Worm Gear Drives.

Herringbone Gear Drives

Link-Belt's large selection of single, double and triple reduction Herringbone Gear Drives adequately fill the bill for small, moderate or large horsepower speed reduction requirements. A mighty good answer to your speed reduction problem. Can we send Book No. 1819 so you can see for yourself?

LINK-BELT COMPANY Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices, Factory Branch Stores and Distributors in Principal Cities. 11.923

LINK-BELT

Power Transmission Machinery
"THE COMPLETE LINE"

Designer's

ANNOUNCING a complete ALL-NEW line

NEMA sizes 0, 1, 2, 3
for a-c motors up to 50 hp

MOTOR STARTERS

Designed for Easy Maintenance

Built so you can forget them

GENERAL ELECTRIC

Digest

TIMELY HIGHLIGHTS ON PRODUCTS

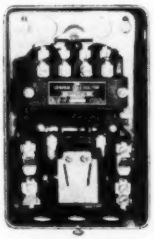
ALL-NEW Magnetic Contactors

Plenty of new features will interest designers in these new G-E a-c contactors, available in NEMA sizes 00, 0, 1, 2 and 3. All terminals are accessible from the front and have large pan-head or slotted hex-head screws to speed wiring. Main poles in sizes 00, 0 and 1—and interlocks in all sizes—can be changed from normally open to normally closed with no extra parts needed. This facilitates last-minute changes and reduces need for stocking "specials." Extra two-circuit interlocks with interchangeable normally open to normally closed contacts can be added to either side of the contactor. Other new features include springs permanently attached to moving contact tips, lock washers fastened to all screws, and long-life magnet with permanent air gap. For easy inspection and maintenance, contacts can be completely exposed for inspection by loosening two screws to remove arc hood, contacts can be replaced without disturbing wiring, and coil is easily replaced by removing four screws which hold magnet in place. See Bulletin GEA-5154.

ALL-NEW 'Strongbox' Magnet Coil

safeguards windings from dust, oil, water

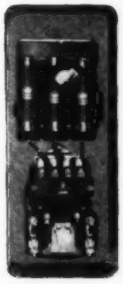
Here's the stout heart of this all-new General Electric line of contactors, starters, and combination starters. Compare it with others and you'll agree the "Strongbox" Magnet Coil is the toughest you've ever seen. For long life even under severe conditions, it's firmly locked in a molded plastic block that completely protects the Formex® windings against dust, oil, and water. A permanent lubricant keeps the moving structure ready for action at all times. Slotted edges in the block keep the magnet travelling in a straight line with minimum wear. Maintenance is quick and easy—permanently anchored terminals won't loosen from the coil, and screwdrivers can't damage windings during wiring.



ALL-NEW Motor Starters

Check these G-E magnetic a-c starters on points that count with machinery manufacturers. Fine silver tips and extra-heavy construction of contacts mean extra long life. Molded, burn-resistant arc hood snuffs arcs at once—prolongs contact life. A flick of the finger changes the overload relays from hand to automatic reset. Available in non-reversing, reversing, and multi-speed types. See Bulletin GEA-5153.

ALL-NEW Combination Starters



A single, compact unit, the new G-E combination magnetic starter saves space and installation time. The rotary-action fused disconnect switch meets all National Electric Code requirements for circuit isolation and short circuit protection. The magnetic starter with its overload relays give the quick response needed to protect your motor from overloads. Units are also available with circuit breakers or non-fusible switches, if desired. See Bulletin GEA-5156.

General Electric Company, Section G668-67
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

- ☐ **GEA-5153—A-c motor starters**
- ☐ **GEA-5154—A-c contactors**
- ☐ **GEA-5156—Combination a-c starters**

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

Name .....

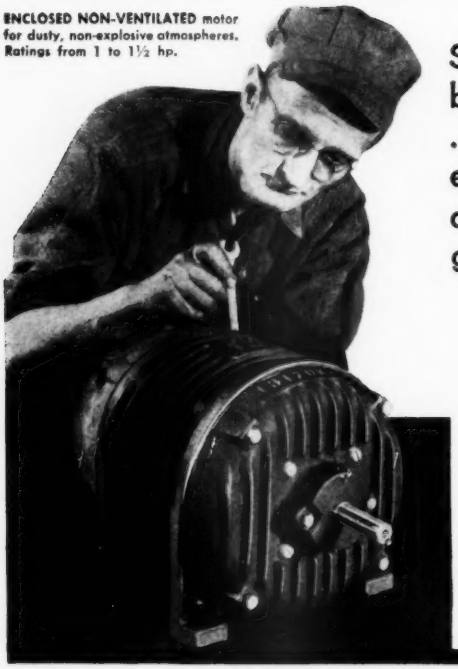
Company .....

Street .....

City ..... **State** .....

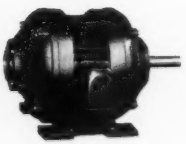
ALLIS-CHALMERS OFFERS EQUIPMENT

Looking for

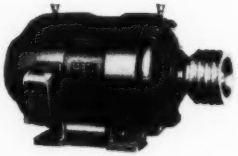


ENCLOSED NON-VENTILATED motor for dusty, non-explosive atmospheres. Ratings from 1 to 1½ hp.

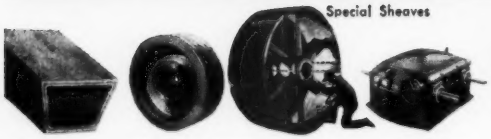
Specify Allis-Chalmers . . . for quality backed by 50 years of motor building . . . a century of manufacturing experience. Motors from ½ HP to any size . . . and a nation-wide certified service program to *keep* your motors running!



GENERAL PURPOSE motor handles 90% of all alternating current motor requirements. Ruggedly constructed with distortionless rotor. Sizes from 1½ to 200 hp.

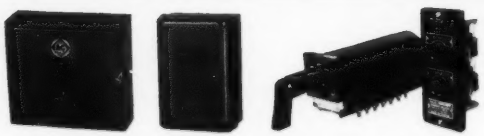


ENCLOSED FAN-COOLED motor for use in dusty atmospheres where danger of explosion does not exist. Suitable for outdoor use. Sizes from ½ to 200 hp.



Special Sheaves

Super-7 V-Belts *Magic-Grip* Sheaves Speed Changers



Motor Starters Rotary Control and Push Buttons

Texrope V-Belt Drives

Fastest delivery in industry on standard V-Belt sizes and lengths. Constant speed drives include complete line of *Texiron, Texsteel, Texdrive, Magic-Grip,* standard cast iron and steel sheaves for section A, B, C, D, and E belts. For adjustable speed, Vari-Pitch sheaves give speed range of 100% per sheave, *Vari-Pitch* speed changers 375% range.

Controls — Any Type or Size

Across-the-line starters for a-c motors range from size 0 to 7. Manual or magnetic, full or reduced voltage starters for any industrial application. Standard, dust-tight, water-tight, and explosion-proof enclosures. Standard and heavy duty push button stations, rotary switches, voltage regulators, contactors and relays.

Sold — Applied — Serviced by Authorized Dealers, Certified Service Shops, and District Offices Throughout U. S.

ALLIS-

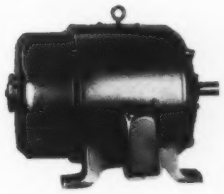
AID TO MACHINE DESIGNERS!

Quality Motors?

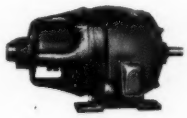
VERTICAL MOTOR TYPE ARV. Available in open, enclosed, fan-cooled, splash-proof, and explosion-proof types. Ratings from 1½ to 200 hp, 25, 50, and 60 cycles.

EXPLOSION-PROOF approved by Underwriters for Class I, Group D, and Class II, Group G locations. Safe in atmospheres containing gasoline, etc. ¾ to 200 hp.

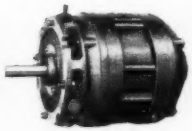
SPLASH-PROOF excludes top or side directed particles or liquids. Squirrel cage type with anti-friction bearings. Available in ratings from 1½ to 200 hp.



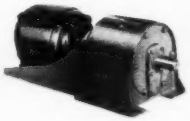
DIRECT CURRENT motors for adjustable speed and continuous reversing drives. Furnished in open, drip-proof, splash-proof and other modifications. ½ to 200 hp.



WOUND ROTOR motor for use where high starting torque and low starting current is required . . . also for adjustable speed drives. Open, splash-proof and enclosed. ½ to 200 hp.



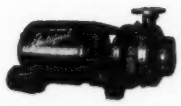
SIDE OR ANGLE mounting motor in open, enclosed fan-cooled, splash-proof and explosion-proof types. Ratings from 1½ to 75 hp. Normal or high starting torque windings.



GEARMOTORS for low-speed drives give speeds from 7.5 rpm to 780 rpm using 1750 rpm motor. Class I, II, and III gears. All motor and integral types. 1 to 75 hp.

GENERAL PURPOSE in ratings from 1 to 7½ hp. Here's a small, tough, squirrel-cage motor with anti-friction bearings. Normal or high starting torque, normal or low starting current.

MULTI-SPEED SQUIRREL CAGE motors in constant torque, variable torque, and constant horsepower types. Two or four speeds. Sizes range from ⅛ to 75 hp. Speeds 450 to 3600 rpm.



Electrifugal Pump.

Coolant and Circulating Pump.

Pumps—10 to 10,000 gpm

Electrifugal pumps have bracket and flange cast integral with motor frame. This insures perfect alignment of pump and motor. Use for general purpose pumping from 15 to 1600 gpm — heads to 180 ft. — motors from ¾ to 25 hp. Complete line of coolant and circulating pumps are now available for quick delivery.

Electrifugal, Texrope, Super-7, Texiron, Texsteel, Texdrive, Magic-Grip and *Vari-Pitch* are Allis-Chalmers trademarks.

CHALMERS

ALLIS-CHALMERS, 1002A SO. 70 ST.
MILWAUKEE, WIS.

A 2465

Please send me:

- ☐ Handy Guide to Electric Motors (51B6052H
- ☐ Handy Guide to Centrifugal Pumps (53B6059D)
- ☐ Handy Guide to Texrope Drives (20B6051H)
- ☐ Variable Voltage Planer Drives
- ☐ Equipment for Machine Tools (2587110)
- ☐ D-C Remote Indications and Controls (1486641)
- ☐ Coolant Circulating Pumps (5286975)
- ☐ General Purpose Motor Controls (1487132)

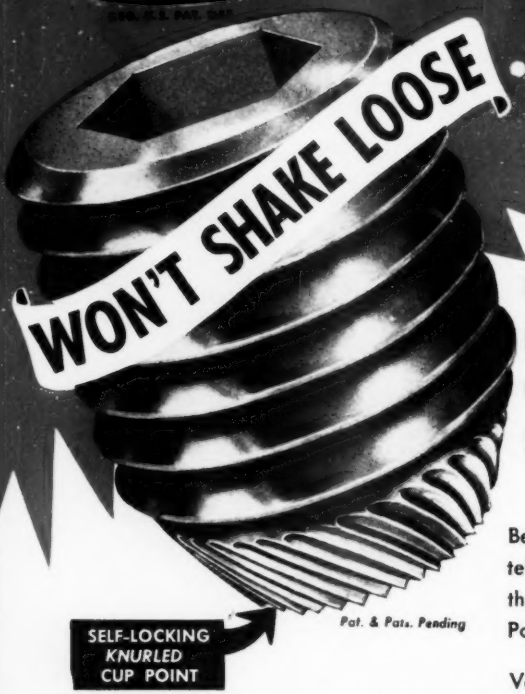
Name.....

Company.....

Street.....

City.....State.....

UNBRAKO



proved by

EXPLANATION OF VIBRATION TESTS DEMONSTRATING THE HOLDING POWERS OF DIFFERENT TYPES OF "UNBRAKO" SOCKET SET SCREWS

Better than words, the graph of actual vibration tests quickly tells the story of the exceptional "HOLDING POWER" of the "Unbrako" Self-Locking Set Screw with the Knurled Cup Point . . . *"the screw that won't shake loose."*

Vertically, the graph is divided into increments of 30 minutes. Each bar—black for Plain Cup Point and red for Knurled Cup Point—represents a screw tested and the number of minutes at which it loosened. *The height of each black bar, therefore, is a direct measure of the length of time before the plain pointed screw shook loose.* The Self-Locking Knurled Cup Pointed Screws—indicated by the red bars—were still tight at 300 minutes.

All screws were tested under identical conditions. Rate of vibration—1750 cycles per minute . . . duration of test—until screw shook loose or tests were discontinued.

Analyzing the graph and comparing the two types of screws, we find that the most favorable test of the Plain Cup Point shows a failure at 10 minutes and 40 seconds. *No Knurled Cup Point shows signs of loosening at 300 minutes—more than 28 times the "HOLDING POWER" of the Plain Cup Point—a tremendous superiority . . . as proven by actual tests and use.*

The "Unbrako" Self-Locking Set Screws with the Knurled Cup Point can be used over and over again.

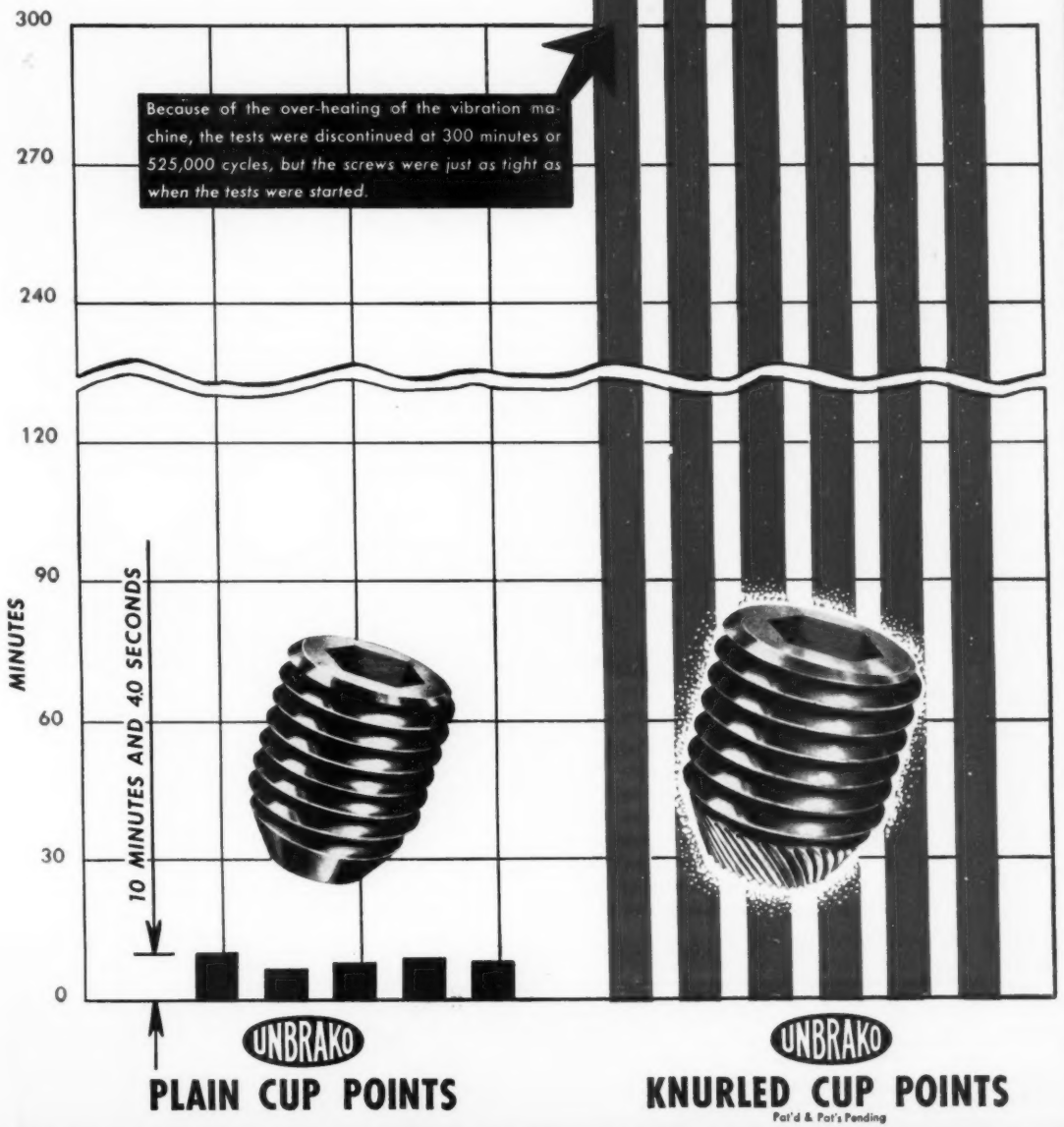
OVER 46 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

BOX 545, JENKINTOWN, PENNSYLVANIA

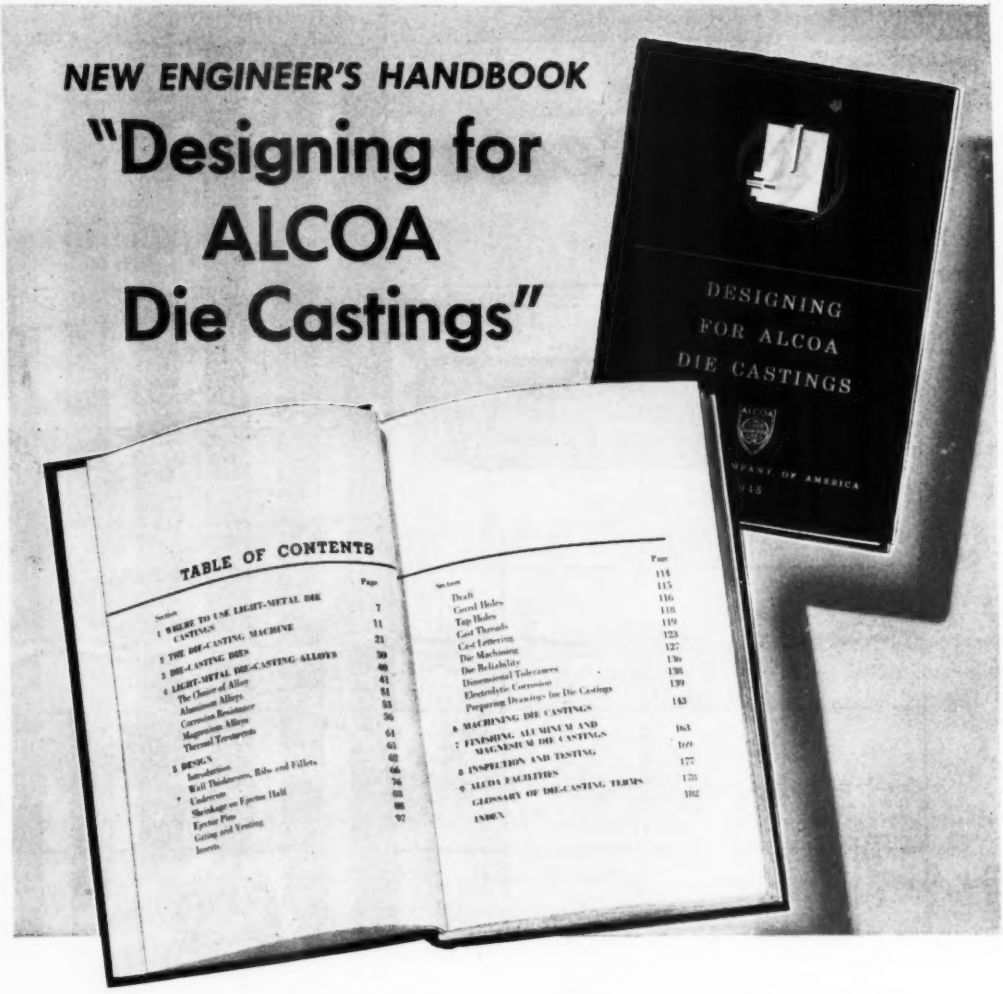
BRANCHES: CHICAGO DETROIT ST. LOUIS SAN FRANCISCO

actual tests



NEW ENGINEER'S HANDBOOK

"Designing for ALCOA Die Castings"



To become fully acquainted with the economies possible with your use of Alcoa Die Castings, write on your company letterhead for your copy of this new Alcoa book.

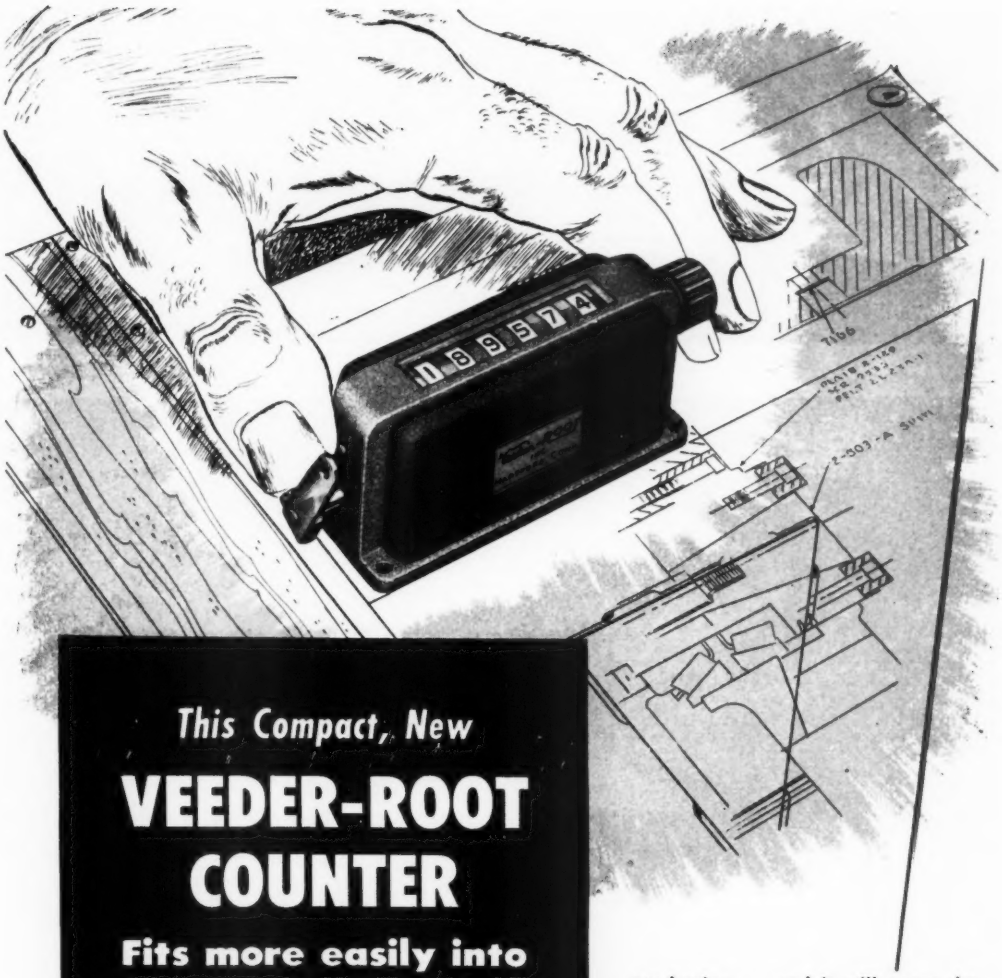
Alcoa means service, from design to delivery. Thirty-four years' experience assures you intelligent design help, correct alloy composition and close alloy control. Alcoa is equipped to cast both aluminum and magnesium, and will give you unbiased advice on the metal best suited to your use.

For "DESIGNING FOR ALCOA DIE CASTINGS", address ALUMINUM COMPANY OF AMERICA, 611 Gulf Building, Pittsburgh 19, Pa. Sales offices in principal cities.

DIE CASTING PLANTS AT CHICAGO, ILL., AND GARWOOD, N. J.

ALCOA LIGHT METAL **DIE CASTINGS**

ALCOA ALUMINUM



This Compact, New

VEEDER-ROOT COUNTER

Fits more easily into any product-design

Trim and slim as a fine timepiece . . . and even easier to read . . . this new general-purpose Series 1260 is the most important news in counters since the Veeder-Root bicycle cyclometer of 1868!

This eye-catching counter, richly finished in 2-tone grey to set off the "Ease-Eye" direct-reading line of 6 bold figures, will measurably add to the *appearance* . . . to the *utility* . . . and to the *marketability* of any machine or product into which it is built as an integral part. It will deliver continuous *Facts in Figures* on any phase of operation or production . . . and it will prove the product's guarantee.

And the new 1260 will fit into the closest design-limitations. For it measures only 4½" long, 1 9/16" high, 1½" wide . . . weighs only 12 ounces. Speeds from 1,000 to 5,000 counts per minute, depending on type of drive: ratchet, revolution, direct, or geared. Capacity is 1,000,000 counts. Then one turn of the knob resets to all zeros.

Look for this good-looking modern counter in the new machines and equipment you buy. And, by all means, look into its possibilities as a built-in *sales-builder for your own products.* Write.

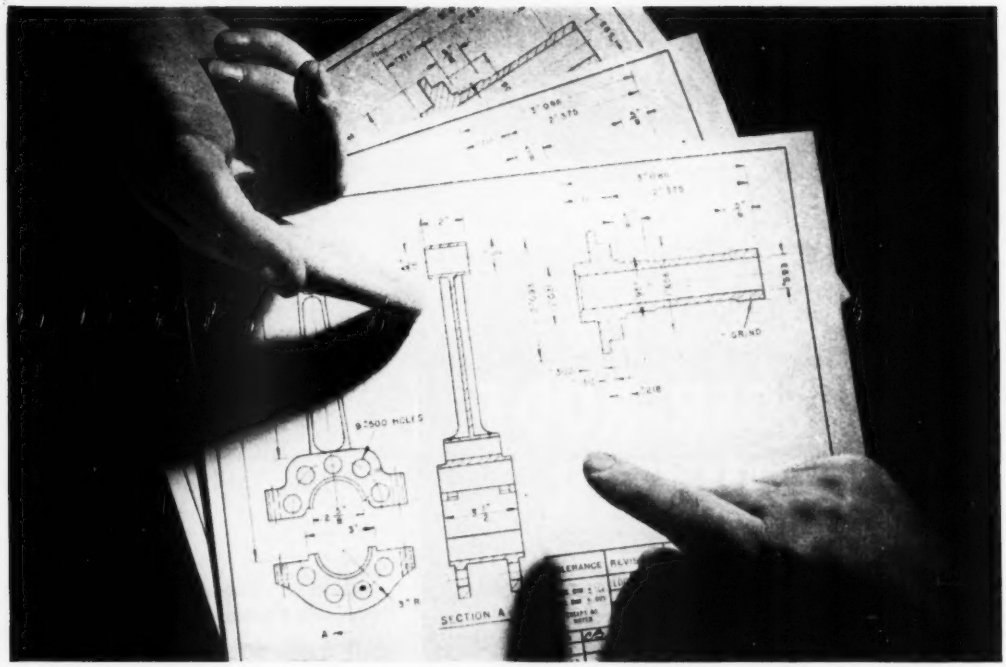
VEEDER-ROOT INC.
Hartford 2, Connecticut

In Canada: Veeder-Root of Canada, Ltd., 995 St. James Street, Montreal 3. *In Great Britain:* Veeder-Root Ltd., Kilspindie Road, Dundee, Scotland

K+E

partners

For 81 years K & E equipment and materials have been



POSITIVE LINE PRINTS THAT ARE CONSISTENT

When you make positive line, dry developed prints, you need consistent results from dependable materials. That is our constant goal in the manufacture of the HELIOS* line of papers, cloths and films.

To be sure of absolute K&E standards in the color-forming components required for these dry diazo products, we established a new plant where we manufacture HELIOS materials exclusively. We not only control and make the finished materials, but actually manufacture, from the raw materials, the image-forming chemical components as well. Thus HELIOS papers, cloths and films are the direct product of 81 years of K&E experience and K&E insistence on quality first.

HELIOS dry developed materials cover a wide field of reproduction needs. They consist of opaque papers (black, blue and maroon line) and opaque cloth for working prints, besides transparent papers and cloth and clear and matte films, for intermediate originals (to use instead of originals).

in creating . . .

partners of the engineer, the scientist and the draftsman in shaping the modern world.

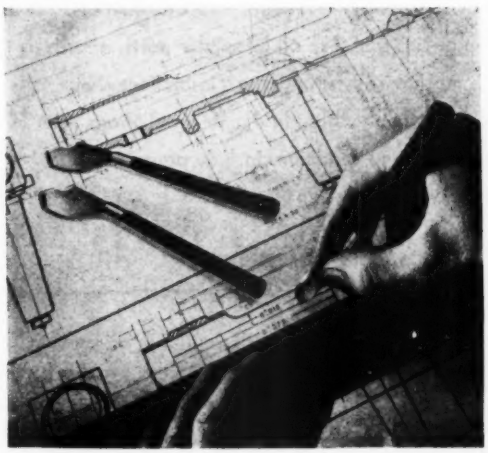
For samples and full information about the HELIOS line and what it can do for you, ask any K&E Branch or Dealer or write us here in Hoboken, N. J.

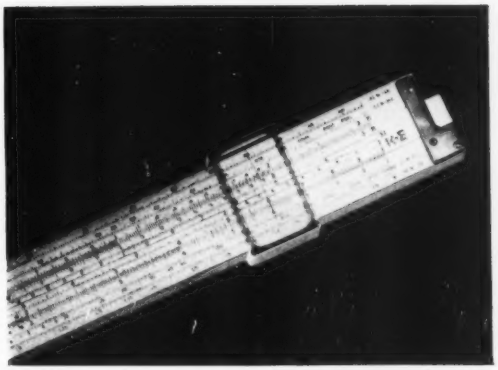
NEW TYPE RULING PENS

MARATHON† Ruling Pens hold several times more ink than ordinary ruling pens. They save refilling time, because they draw five to eight times more line between fillings. They are made in three fixed widths to rule three different widths of line. The ink-flow is regular and lines are always sharp, clean and uniform in width.

MARATHON Pens are easy to handle for guided curve lines or freehand contour line work. They can be laid down flat even when filled, without the ink running out. Easily filled, cleaned and sharpened. Sold in sets of three or singly.

Ask your K&E Dealer or K&E Branch to show them to you.





YOUR SLIDE RULE

To the engineer, scientist, mathematician and student, Slide Rules and K&E are synonymous. The new N4080 and N4081 LOG LOG DUPLEX TRIG and DECITRIG* rules, for instance, are typical of the thoroughly seasoned materials, the precision and detail of workmanship for which K&E Slide Rules have long been recognized as the standard of quality.

When you need a Slide Rule, insist on K&E.

*Trade Mark®
†Trade Mark

KEUFFEL & ESSER CO.

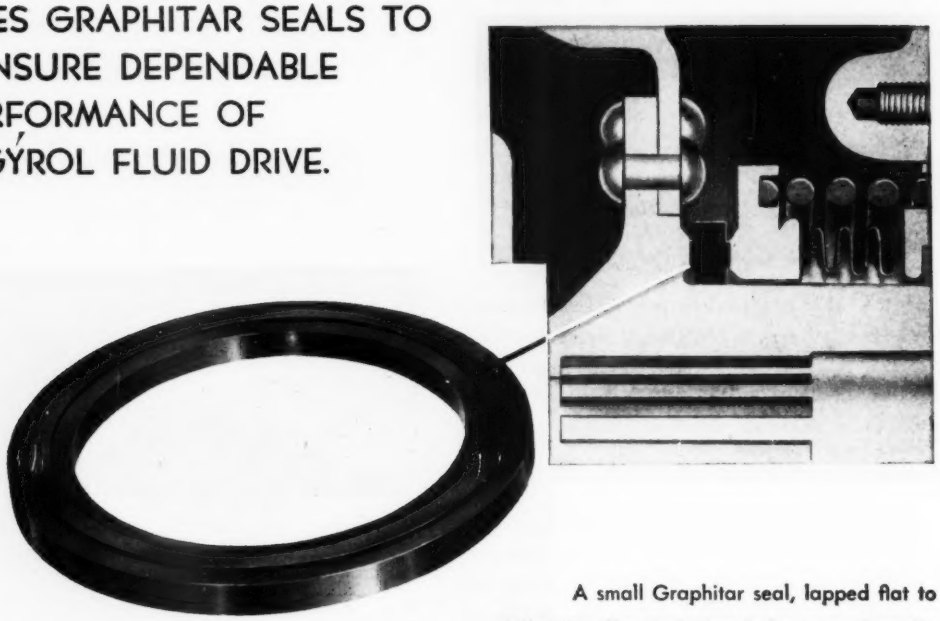
NEW YORK • HOBOKEN, N. J.
CHICAGO • ST. LOUIS • DETROIT • SAN FRANCISCO
LOS ANGELES • MONTREAL

graphitar seal helps

(CARBON-GRAPHITE)

# of gyrol fluid drive unit

AMERICAN BLOWER CORPORATION
USES GRAPHITAR SEALS TO
INSURE DEPENDABLE
PERFORMANCE OF
GYROL FLUID DRIVE.

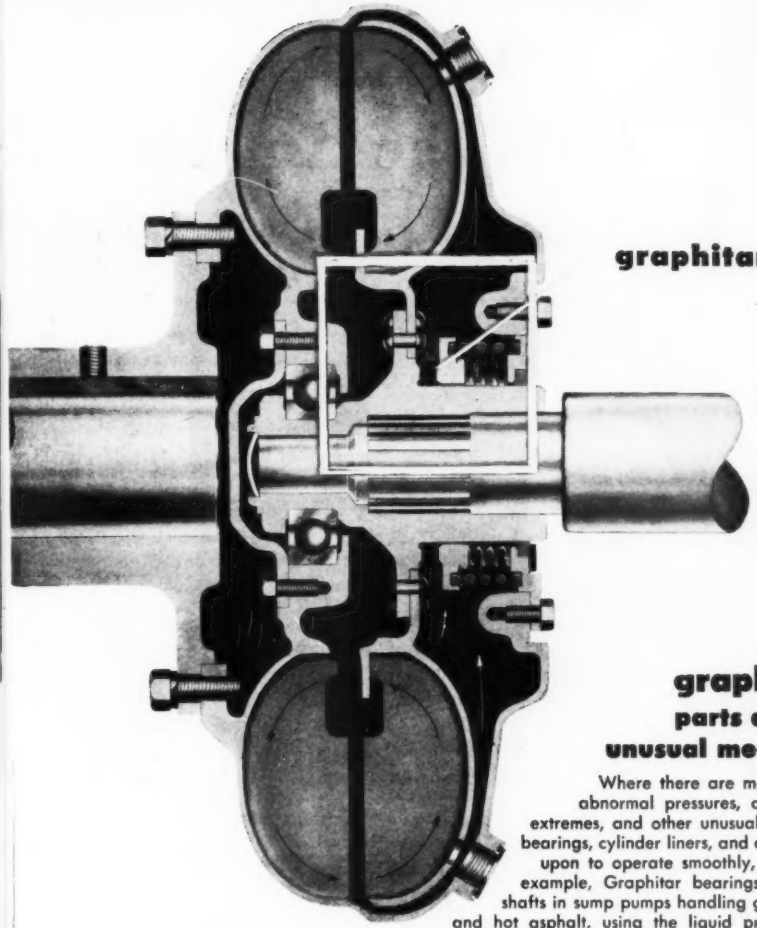


A small Graphitar seal, lapped flat to within 35 millionths inches, helps to produce the dependable performance of the Gyrol Fluid Drive manufactured by American Blower Corp. Installed as shown, the Graphitar seal floats free, seals with no leakage whatsoever, and requires no lubrication because its carbon-graphite composition is self-lubricating. This seal, like all Graphitar parts, affords maximum resistance to friction and wear, it is mechanically strong and it is unaffected by chemical attack and sudden and extreme temperature changes. In similar installations, Graphitar seals assure efficient sealing where operating conditions include pressures up to 60 lb./sq. in. at 350°F. and 1000 ft./min., and temperatures up to 550°F.

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

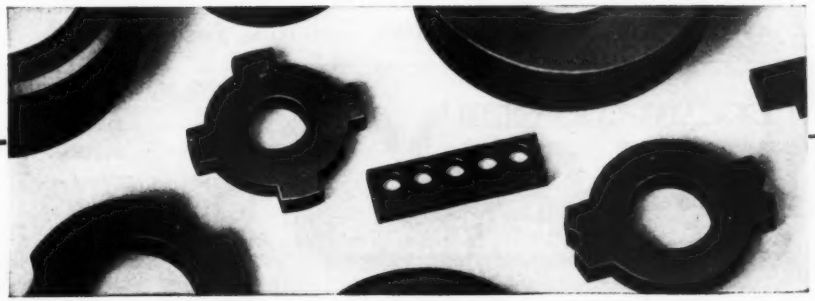
...aintain high efficiency

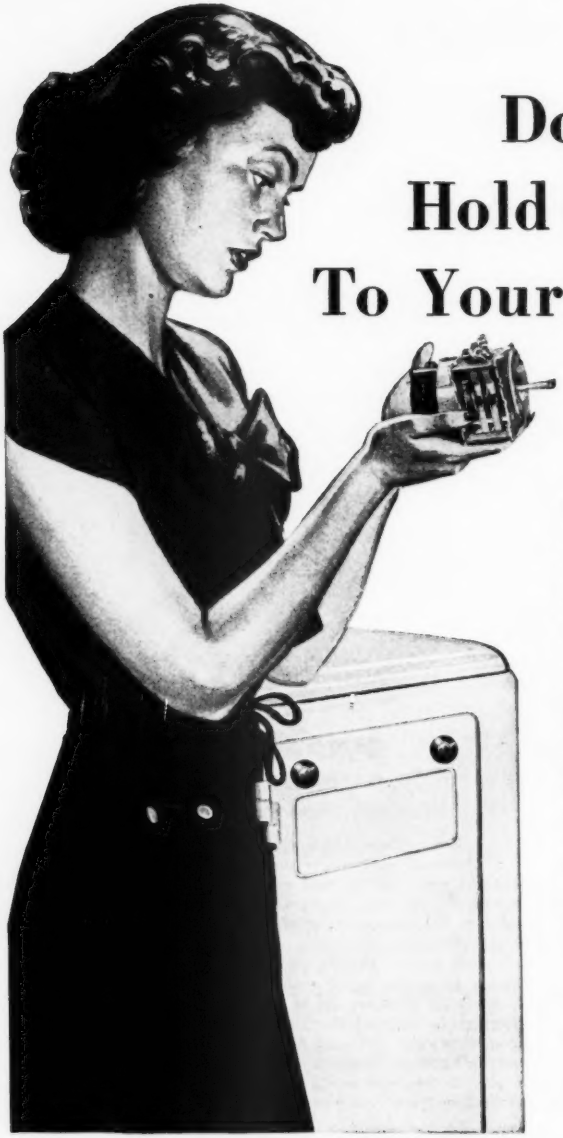


graphitar seal

graphitar
parts are made to meet unusual mechanical demands

Where there are mechanical problems involving abnormal pressures, chemical attack, temperature extremes, and other unusual conditions, Graphitar seals, bearings, cylinder liners, and other parts may be depended upon to operate smoothly, efficiently, and quietly. For example, Graphitar bearings align and support vertical shafts in sump pumps handling gasoline, alcohol, molten salt, and hot asphalt, using the liquid present as lubricant to insure dependable pumping at pressures up to 200 psi, temperatures to 1000°F., and speeds to 1200 ft./min. The successful applications of Graphitar, in various shapes and with close tolerance dimensions, are too numerous to list—but, if you will send us sketches or descriptions of your products our engineers will be glad to show you where Graphitar parts will improve mechanical performance and save you money. Ask for 44-page catalog.





Does She Hold the Answer To Your Competition?

Getting the jump on the rest of the field with a better designed product is still the best way to win leadership. The young lady is holding a Mallory product that helped to turn the home washing machine business upside down . . . and widen the national market tremendously.

It's the Mallory Interval Timer Switch—the mechanical "brain" that makes possible the various steps in the cycle of filling, washing, rinsing, damp-drying, cleaning, and emptying modern automatic home laundries. This high-quality, low cost time cycle switch is responsible for the sale of millions of automatic washing machines.

The automatic washing machine is only one of the many applications for the Mallory Interval Timer Switch. We suggest you take a moment to consider how the Mallory Interval Timer Switch could make your product more efficient and give it a new sales plus to get a jump on competition.

Manufacturers and designers are invited to write for additional information. And our engineers will be glad to work with you in developing a timer switch for your product.

Precision Electronic Parts—Switches, Controls, Resistors

P.R. MALLORY & CO. Inc.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

SERVING INDUSTRY WITH

Capacitors — Rectifiers
Contacts — Switches
Controls — Vibrators
Power Supplies
Resistance Welding Materials

KEROSENE LAMPS IN YOUR DRAFTING ROOM?

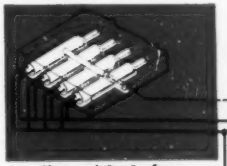
CERTAINLY NOT!

And General Electric Calrod* Heaters can solve your surface heating design problems in the same way you light your offices . . . electrically! Yet some designers are still trying to solve surface heating problems with equipment almost as antiquated as the kerosene lamp . . . when it is so easy to apply uniform, easy-to-control, surface heat with G-E Calrod Heaters like this . . .

*Reg. U. S. Pat. Off.

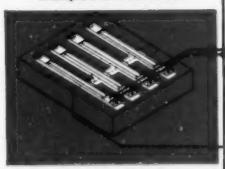
Typical Surface-Heating Applications with General Electric CALROD Heaters

Inserted Into Drilled Holes



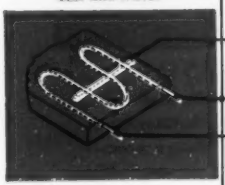
CALROD CARTRIDGE HEATERS Where space is limited, space-saving, fast-heating, cartridge heaters may be inserted into drilled holes or cast into metals. Sheaths of brass, nickel-silver, or chrome-steel in ratings from 30 to 1200 watts; sheath temperatures up to 1200 F.

Clamped On Surfaces

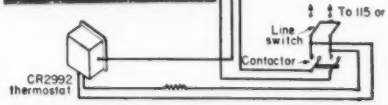


CALROD STRIP HEATERS Clamp easy-to-install strip heaters on surfaces in jig-time. Flat surfaces provide excellent heat conduction. Available in two types: steel-sheathed for temperatures up to 750 F; chrome-sheathed for temperatures up to 1200 F.

Cast Into Metal



CALROD TUBULAR HEATERS Can be bent into any shape, cast into metal, clamped on surfaces, or inserted into drilled holes. Sheathed in steel, nickel-silver, or high-temperature alloys. Ratings from 500 to 7500 watts. Sheath temperatures up to 1500 F.



G-E Thermostat (CR2992) controls Calrod heaters accurately and effectively over a wide range of temperatures up to 750 F.

platens ● pre-shrinking machines ● packaging machines injection molding machines ● cigarette machines ● textile machinery ● bottle capping ● die heating ● embossing food-vending machines ● matrix scorching ● molding presses ● valve warming ● rubber molding machines ● roll heating ● sand drying ● aluminum extrusion ● paper machinery ● vulcanizing machinery ● tire recapping equipment

There is a G-E Calrod heater for virtually every surface-heating requirement and every surface. For best results, consult your G-E Heating Specialist before you design.

For valuable surface-heating ideas and application data, get your FREE COPY of the new publication, "HEATING SURFACES," GEA-5097. Just clip and mail the coupon.

MAKE THINGS "HOT"

Apparatus Department, Sect. B 720-1
General Electric Company, Schenectady 5, N. Y.

Please send me a copy of your new, idea-packed publication, "HEATING SURFACES," GEA-5097.

Name.....
Company.....
Address.....
City..... **State**.....

GENERAL ELECTRIC

It STAYS CLEANER LONGER....

See why the

C-W SEALEDPOWER

TOTALLY-ENCLOSED....FAN-COOLED MOTOR

SAVES 80% OF MAINTENANCE COSTS

COMPARE CLEANING COSTS!

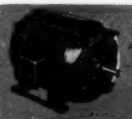
	Conventional* Fan-Cooled Motor	VS	C-W Sealedpower Motor
	Normal (Not Extra Dirty) Service		
FREQUENCY	**EVERY YEAR** a conventional fan-cooled motor requires cleaning, in the opinion of experienced maintenance chiefs.		**ONCE EVERY 3 YEARS** is often enough for a Sealedpower motor, according to those who have had experience with it.
OPERATIONS REQUIRED	**17 OPERATIONS**—to shut down, dismantle, clean and reassemble motor. Motor must be shut down and taken out of production, for about 3 hours.		**NO NEED TO SHUT DOWN** in normal—not extra dirty—duty, no need to remove fan cowl, etc. Brushing cowl end, and cleaning outside of motor is sufficient.
TIME, LABOR COSTS	**$4.95** **3 HOURS** time, estimated by motor maintenance men, at union scale of $1.65 per hour, totals $4.95 yearly per motor, in normal service.		**14¢** **¼ HOUR** time, once every 3 years, cleans a Sealedpower motor. At $1.65 per hour, cleaning cost per year is only 14¢.
COSTS IN ABNORMAL SERVICE	**EVERY 3 MONTHS,** a conventional motor, operating where dirt or lint is excessive, should be cleaned. That requires 18 hrs. of labor at $1.65, for a total cleaning cost of $29.70 per motor, during an interval of 18 months.		**ONLY ONE** cleaning every 18 months keeps a Sealedpower motor running cool and efficiently. Only ¾ hour to remove fan cowl, brush fan and outside of motor and replace cowl. A labor cost of only $1.24 per motor.

**A totally-enclosed, fan-cooled motor, of conventional design, was used for comparison*

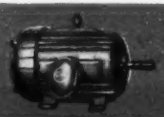
You get this *dollar-saving design* only when you specify C-W Sealedpower Motors. No other totally-enclosed, fan-cooled motor has exterior cooling, with the fan-driven airstream blowing over the finned frame, carrying dust and fumes *outside* and *away*. It beats rust and corrosion, too, because the frame is rugged *cast iron*.

RATINGS FROM 3 TO 60 HP, horizontal or vertical, with NEMA "C" or "D" flange mountings. Many ratings are stocked . . . see C-W's weekly Stock Sheet. Talk over your motor needs with a Crocker-Wheeler representative.

FOR ANY APPLICATION WHERE EXCESSIVE MAINTENANCE IS INDICATED —specify *SEALEDPOWER and SAVE*

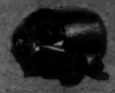


Protected-Type Motors



Sealedpower Motors

Wound Rotor Motors



Direct Current Motors

Generators

Flexible Couplings

It SKIPS SHUTDOWNS

150% MORE COOLING SURFACE

is provided by the radiating fins, exclusive with the C-W SEALEDPOWER. Here, fluttering streamers trace the fan-driven airstream that blows dust and fumes outside and away.

CROCKER WHEELER

ELECTRIC MANUFACTURING COMPANY, AMPERE 3, N. J.

A Division of The Joshua Hendy Corporation

Branch Offices:
Boston, Buffalo, Chicago, Cincinnati, Cleveland, Los Angeles, Milwaukee, New York, Philadelphia, San Francisco, Pittsburgh, Washington, D. C.—Representatives in principal cities.

Before You Buy ANY totally-enclosed motor, be sure to read why SEALEDPOWER will prove a "maintenance miser" for you. This new booklet, "It's Different—it's a Dollar-saver," is packed with facts no savings-minded motor user can afford to overlook. Write for it.

Crocker-Wheeler Electric Mfg. Co.
Ampere 3, N. J.

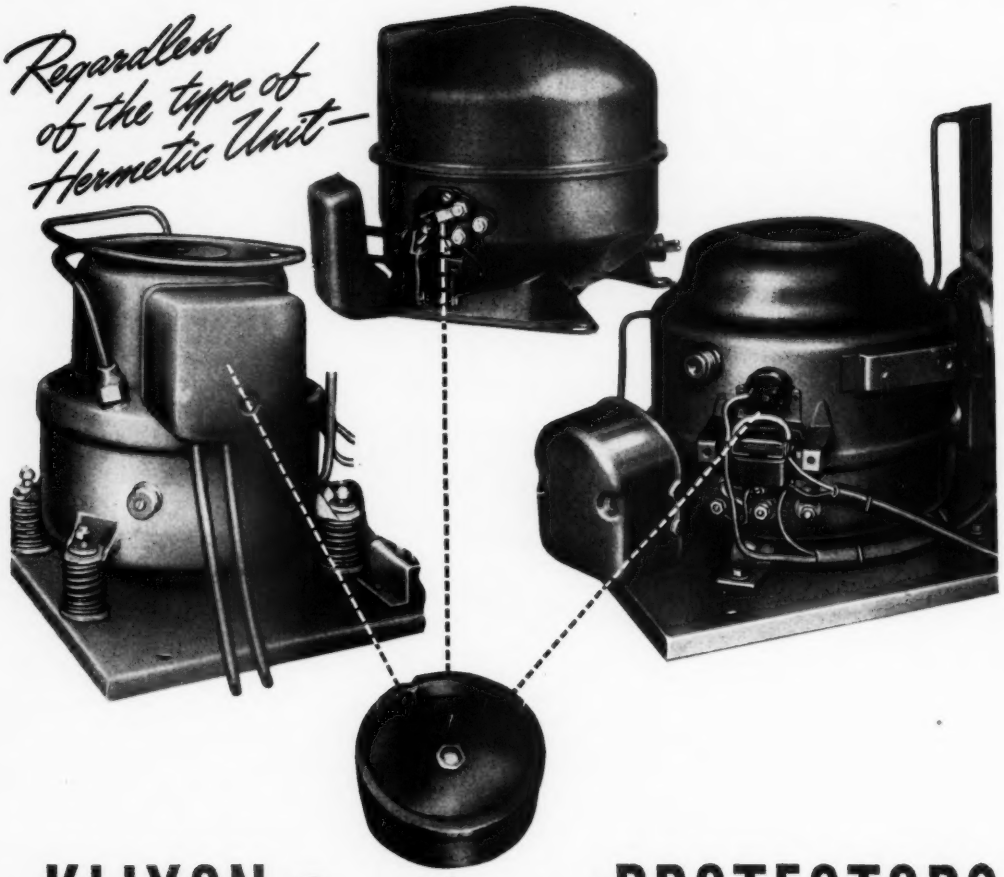
Send the SEALEDPOWER Motor Booklet, *"It's Different—it's a Dollar-Saver"*, PD-249

Name .....

Title or Function .....

Company .....

Address .....



KLIXON *Dome Mounted* PROTECTORS

Provide Positive Motor Protection

- ***Prevent Motor Burnouts***
- ***Reduce Factory Returns***
- ***Enable the Unit to Maintain Refrigeration***

Klixon Motor Starting Relay completes the combination required to start and protect the hermetic motor. Its positive action and long life eliminate starting troubles and make it a fitting companion for the Klixon Protector. Used and recommended by leading refrigeration manufacturers.

Although hermetically sealed units vary in design, they all can have sure motor burnout protection with Klixon dome mounted Protectors.

Mounted on the dome where they follow every temperature change, a Klixon Protector prevents the motor from burning out by shutting "off" the power should the motor become dangerously overheated. When it cools sufficiently, the Klixon Protector snaps the power "on" again automatically enabling the unit to provide refrigeration. And because it is built-in by the hermetic manufacturer, you get a tested and proven combination that will protect the motor for the entire life of the refrigerator.

Don't forget that motors with Klixon Protectors should also be used with open type compressors. Whether you are a manufacturer of hermetic or open type compressors or a user of these units, it will pay you to use Klixon Protectors.

KLIXON

SPENCER THERMOSTAT DIVISION Metals & Controls Corporation
902 FOREST STREET ATTLEBORO, MASS.

THIS PAGE FOR IMAGINEERS

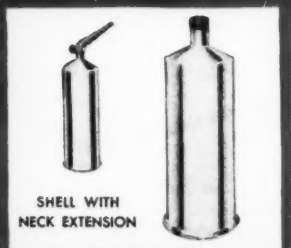
. ALCOA'S IMPACT EXTRUSION PROCESS OFFERS CHALLENGE TO

Improve your product, cut your costs!

In a fraction of a second, a slug of aluminum becomes a semifinished part, in the Alcoa Impact Extrusion Presses. Here, formed in one swift stroke, can be a housing, or shell, or body, or cylinder; strong, stiff, ready for final assembly operations. A part with sides and bottom integral; as large as 5″ in diameter, 16″ long!

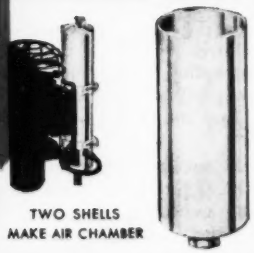
Eliminate expensive, time-consuming operations. Shapes that formerly required assembly of two or more parts are produced at high-production rates. Bosses, lugs, stems, and necks may be formed integrally with the shape, in the same operation.

In one stroke, an Alcoa Impact Extrusion can revolutionize production and assembly of your product; can add beauty of line and form that boost sales. A quick glance at the possibilities shown here should prompt you to write for the new booklet "Alcoa Aluminum Impact Extrusions", or phone your nearest Alcoa sales office. ALUMINUM COMPANY OF AMERICA, 692 Gulf Building, Pittsburgh 19, Pennsylvania.



SHELL WITH NECK EXTENSION

HEAVY RIBBED HOUSING



TWO SHELLS MAKE AIR CHAMBER

Write for this 44-page book today! Gives full details.

ALCOA Aluminum IMPACT EXTRUSIONS

ALCOA ALUMINUM

STRONGER PARTS AT LOWER COST!

Presteel Stampings Eliminate Costly Machining . . . Improve Product!

The cutter bar and chain cover for this power hedge shear graphically illustrate how Presteel combines craftsmanship and expert tool design with modern methods and equipment to produce stronger metal parts at lower cost.

Identical grooves in both parts are required, to a depth 50% beyond thickness, to permit free passage of the speedy chain. Previously, these grooves were machined, but removal of the metal weakened the structure.

Presteel accurately forms and pierces these large area parts on heavy presses from .125 cold rolled annealed steel. By coining the grooves, the metal is forced back into the parts — hardening, toughening and increasing their strength. Through proper tool design, Presteel controls the flow of metal to form the sides of the grooves, sharp and square — perpendicular to the face. Machining is entirely eliminated.

Manufacturers are looking to Presteel for assistance in the design and redesign of metal stampings that will reduce production costs. Perhaps you have a problem where our metal working knowledge will save you money! Tell your story to our representative or write us direct!

Representatives in

ALEXANDRIA, VA.
BUFFALO
CANTON, OHIO
CHICAGO
DENVER
DETROIT
FORT WORTH
INDIANAPOLIS
LOS ANGELES
NEW YORK
PHILADELPHIA
SYRACUSE
TORONTO, CANADA

ALLOY STEELS AND OTHER METALS COLD FASHIONED SINCE 1863

WORCESTER PRESSED STEEL CO.

702 BARBER AVENUE
WORCESTER 6, MASS.

Build more "SELL" into your product with

NOW PREEN-X

the *New Idea* in HEATER CORDS

From now on you'll hear a lot about the amazing new General Electric Preen-X heater cord. It's the heater cord that has more than ten times the abrasion resistance of ordinary heater cords – a heater cord that has no loose braid, nothing that can fray.

General Electric Preen-X heater cord eliminates annoying kinking – resists hard usage, water and oil. It's the kind of cord you've wanted for your product. And it's available now in this brand-new General Electric cord set complete with the smart, G-E "400" plug.

For more information on the new G-E Preen-X cord with the colorful "400" plug, contact the General Electric Accessory Equipment district representative in your area, or write to Section Q39-267, Construction Materials Department, General Electric Company, Bridgeport 2, Connecticut.

RADIOS, FANS, CLOCKS, and other light-duty appliances get a real sales boost when they're equipped with the smart General Electric Flamenol* cord set. This tough, good-looking cord set comes in brown or ivory, with the durable plastic plug firmly molded onto the Flamenol cord. Order them in six-, eight-, or eleven-foot lengths, stripped and ready to be mounted on your product. As an extra merchandising aid, you can obtain the bright, G-E Flamenol tag to display on every item equipped with the General Electric Flamenol cord set.

FLUORESCENT ACCESSORIES—Building a fixture using fluorescents? You'll find it pays to choose from General Electric's complete line of accessories for a better product, for better product acceptance. The famous Turret* lampholders and Watch Dog* starters—and a wide range of standard switches, sockets, and lampholders—are all part of the General Electric line.

CORD SET ASSEMBLIES may be costing you too much in time and plant space. General Electric's cord set service is equipped to wire sockets and switches into complete cord set assemblies, and ship them to you at a reasonable charge. Why not investigate this service as a method of cutting your assembly costs?

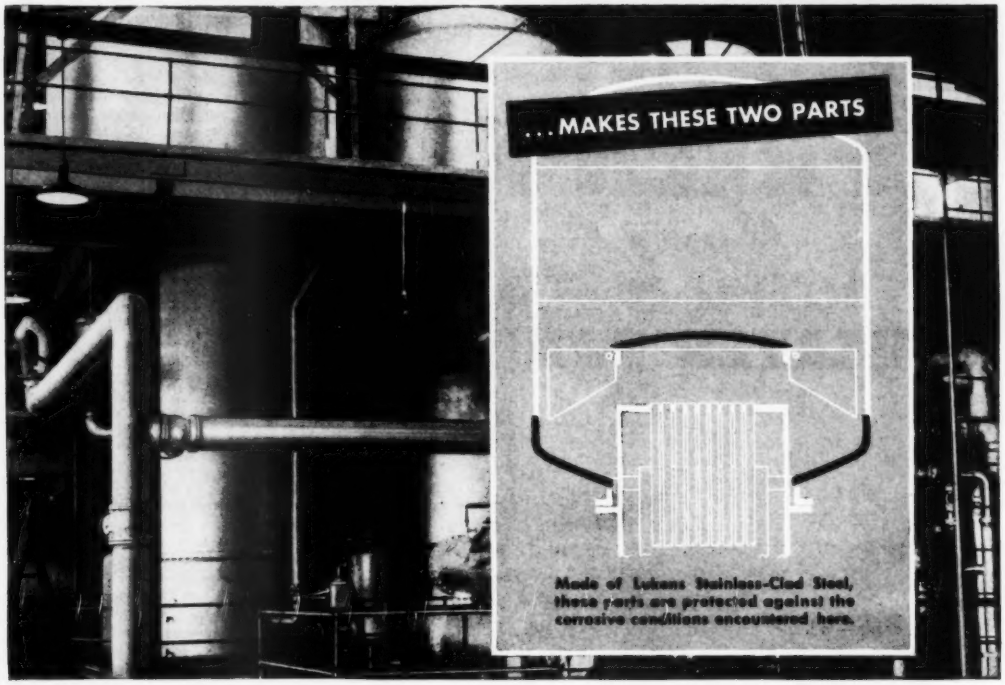
IF YOU NEED INFORMATION, we'll be glad to tell you about our complete service to manufacturers—our merchandising aids—and our complete line of components. For information, write to Section Q39-267, Construction Materials Department, General Electric Company, Bridgeport 2, Connecticut.

*Trade-mark Reg. U. S. Pat. Off.

GENERAL ELECTRIC

Preen-X Cords WITH THE NEW "400" Plugs

ONE LUKENS HEAD-SHAPE


...MAKES THESE TWO PARTS
Made of Lukens Stainless-Clad Steel, these parts are protected against the corrosive conditions encountered here.

Starting with a Lukens Flanged and Dished Head-Shape, Swenson Evaporator Company cuts out the center and produces two parts for this vapor head—the bottom ring and the deflector. Made of Lukens Stainless-Clad Steel, both are highly resistant to the erosive and corrosive effects of the liquid which impinges against them.

Have you products with parts that are basically "head-shaped"? You can save, as other manufacturers are doing, by starting with Lukens Head-Shapes, thus avoiding those initial forming operations. Equipment and labor are released for other operations, producing more finished goods without increase in plant investment.

3,868 standard Lukens Head-Shapes are described in Lukens Catalog No. 1, enabling you to choose from them in designing new products. Many sizes and shapes in stock are listed in Bulletin No. 433. Lukens has hundreds of dies for forming others, permitting prompt shipment.

For copies of these publications, write Lukens Steel Company, 405 Lukens Bldg., Coatesville, Pa.

LUKENS HEADS

"Head Work", a 16mm motion picture in sound and color, on spinning and pressing of Lukens Heads is available without charge. Running time: 27 minutes. Write for a booking date.

FOUR INCHES TO OVER TWENTY FEET IN DIAMETER

• • SPEED SCRAP TO THE MILLS TO MAKE MORE STEEL • •

Are you on a "Spot"?

IF you need manufacturing facilities for metal working, contact us at once. Here is how we serve industry: furnish additional production capacity for new items or manufacture established products more efficiently. Working on a firm contract with you, we assemble and ship directly to you or your customer, on a definite delivery schedule. We have worked with manufacturers in diversified fields, offering designing, engineering and tooling services for complete products or component parts.

Write, wire or phone us. Tell us your metal working problem and find out how we can serve you. The complete facilities we offer consist of Sheet Metal Fabricating—20 gauge to ¼" Plate, Machine Shop, Metal Spinning and Finishing to 14 gauge.

Write for a copy of our folder, "We Have Our Ups and Downs". Find out how we helped a manufacturer who was "on a spot".

IN THE HUB OF INDUSTRY

CINCINNATI METALCRAFTS INC.
Division B

5000 BROTHERTON ROAD, CINCINNATI 9, OHIO
Phone: REdwood 2214

PLAN YOUR PRODUCTION ALONG THESE LINES...

Keep your costs down and production up with Reynolds Aluminum parts Contract Service.

Not many manufacturers would undertake an expansion to include the complete facilities and experienced manpower offered by Reynolds. But every manufacturer should investigate the service that combines those advantages with the light weight, long lived, low cost qualities of aluminum. Reynolds can supply you with aluminum parts or complete assemblies—as you specify—in quantities you need—on the date you name.

You get the savings of mass production and a dependable source of supply. Quality and scheduling are controlled from mine to finished parts. There is no scrap to handle, sort and ship. As a result, costs on some parts have been reduced as much as 30%.

A number of leading manufacturers are already profiting from this complete contract service. For a list of equipment and other advantages, mail the coupon below. Or call the Reynolds Field Office listed under "Aluminum" in your classified telephone directory. Reynolds Metals Company, Industrial Parts Division, Louisville 1, Ky.

Reynolds Metals Company

INDUSTRIAL PARTS DIVISION

REYNOLDS ALUMINUM

A complete aluminum fabrication service including blanking • embossing • stamping • drawing • spinning • forming • roll shaping • assembling and finishing •

REYNOLDS METALS COMPANY
Industrial Parts Division
2050 South Ninth Street, Louisville 1, Kentucky

Send the new folder on Aluminum Parts and Assemblies.

Name_____ Title_____

Street Address_____

City_____ Zone_____ State_____

REYNOLDS PIONEERING MADE ALUMINUM COMPETITIVE...*TAKE ADVANTAGE OF IT!*

WEIRTON

COLD-ROLLED STRIP

The use of Weirton cold-rolled strip steel can be a big factor in maintaining high volume at low cost in the making of countless articles or parts. Its exceptional drawing and forming qualities speed up and simplify production. Costs are cut because spoilage and scrap losses and tool expense are reduced. Plant efficiency and product efficiency are improved through standardization on Weirton cold-rolled strip steel.

WEIRTON STEEL CO.

WEIRTON, W. VA., *Sales Offices in Principal Cities*

Division of **NATIONAL STEEL CORPORATION,** *Executive Offices, Pittsburgh, Pennsylvania*

Tune in "Suspense!," radio adventure at its greatest—Thursday, 9 p. m., E. S. T. on CBS

DESIGN for better living!

• New beauty, convenience, economy has been made possible through the use of plastics and metal and plastic combinations. The modern automobile has demonstrated this great potential. And the broad scope of the varied applications is being repeated again and again throughout industry.

Here under one roof at Auto-Lite's great Bay Manufacturing Division in Bay City are the technical skills and production capacity for a new art rendered in plastics. The artistic skill of Auto-Lite's Art and Style Division is available on matters of design and development.

THE ELECTRIC AUTO-LITE COMPANY
Bay Manufacturing Division
723 New Center Bldg., Detroit 2, Michigan • Bay City, Michigan

Auto-Lite
plastics and metals

AUTO-LITE MEANS PRECISION MANUFACTURING

This booklet tells you why...

ONLY PHILLIPS SCREWS offer these 5 essentials of a STANDARD Cross Recessed Head Screw

How to Select RECESSED HEAD SCREWS for PRACTICAL PRODUCTION DRIVING
A GUIDE TO ASSEMBLY SAVINGS
It must offer substantial savings in product assembly costs.
It must offer easily-demonstrated mechanical advantages over all other recess designs.
Its dimensional uniformity must be rigidly controlled and universally dependable.
It must be made available in any volume required by industry at any time.
It must attain popular recognition and unlimited acceptance throughout industry.

Because Phillips, and *only* Phillips Recessed Head Screws meet all five requirements, they are your logical choice for practical production driving. Specify Phillips and gain *all* the advantages that *standard* Cross Recessed Head Screws can contribute to your product's manufacture.

Everyone in industry responsible for screw selection should have this Fact-Full Booklet.

It lets you in on the important facts you can't afford to overlook when you choose cross recessed head screws. It's FREE. Use the coupon . . . send it today.

PHILLIPS *Recessed Head* SCREWS

Wood Screws • Machine Screws • Self-tapping Screws • Stove Bolts

27 SOURCES

American Screw Co.
Camcar Products Co.
Central Screw Co.
Continental Screw Co.
Corbin Screw Div. of American Hdws. Corp.
Eko Tool & Screw Corp.
The H. M. Harper Co.
Lamson & Sessions Co.
Milford Rivet and Machine Co.
National Lock Co.
National Screw & Mfg. Co.
New England Screw Co.
Parker-Kalon Corporation
Pawtucket Screw Co.
Phoenl Manufacturing Co.
Reading Screw Co.
Rockford Screw Products Co.
Russell Burdsall & Ward Bolt & Nut Co.
Scovill Manufacturing Co.
Seaboard Screw Corp.
Shakeproof Inc.
The Southington Hardware Mfg. Co.
The Steel Company of Canada, Ltd.
Sterling Bolt Co.
Stronghold Screw Products, Inc.
Wales-Beech Corp.
Wolverine Bolt Company

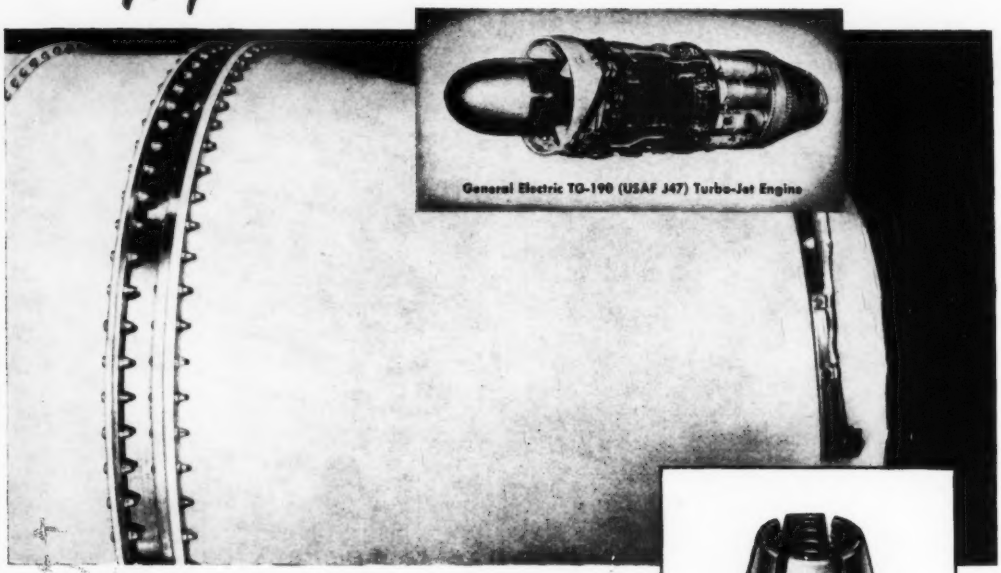
Phillips Screw Mfrs., c/o Horton-Noyes Co.
1800 Industrial Trust Bldg., Providence, R. I.
Send me the new booklet—"How to Select Recessed Head Screws for Practical Production Driving".

Name .....

Company PE-38

Address .....

NEW! *High-Temp Nut* HOLDS WITHOUT SEIZURE AT 1200°F.



Self-locking Elastic Deflection protects against

VIBRATION! *permits* INTERCHANGEABILITY!

The extreme heat generated in exhaust manifold systems, turbo-jet tail cones and similar installations create strength and seizure problems in ordinary fasteners—problems that are solved by ESNA's NEW Z-1200 Hex and Anchor Nuts.

These new nuts shown above on the tail cone flanges of the General Electric TG-190 retain their strength and locking torque characteristics even after repeated use at 1200°F. They are readily removed . . . do not seize the bolt or damage the threads.

Further, the elastic deflection built into the Z-1200's locking-beams makes them re-usable—interchangeably . . . because exact design assures locking torque within the tolerance range of Class 3 bolts.

ESNA Z-1200 Nuts—like all Elastic Stop Nuts—are designed for rapid field service replacements to simplify maintenance. They are self-locking anywhere on a bolt or stud without frictional aid from bolt tension or seat pressure.

HERE'S A CHALLENGE. Send us complete details of your toughest bolted trouble spot. We'll supply test nuts—FREE, in experimental quantities. Or, if you want further information, write for literature.

Elastic Stop Nut Corporation of America, Union, New Jersey. Representatives and Agents are located in many principal cities.

HIGH TEMPERATURE NUTS
HEX AND ANCHOR—FOR 1200 F
(Esna Type Z-1200)

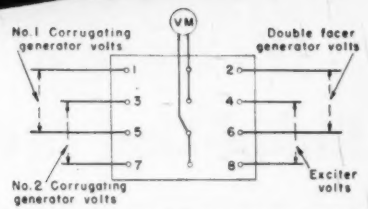
Stainless Steel type 18-8 Columbium stabilized, silver plated, the new ESNA Z-1200 nuts will NOT seize the bolt or gall the finish. Vibration, impact or stress reversal will not disturb their pre-stressed or positioned settings.

THEY ARE RE-USABLE

ELASTIC STOP NUTS

OVER 150 TYPES AND SIZES IMMEDIATELY AVAILABLE FROM STOCK

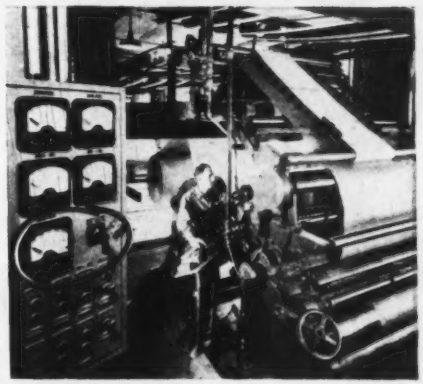
this job... VOLTMETER READINGS ON CORRUGATING MACHINE



Here's the circuit—An SB-1 used as a voltmeter selector switch. One switch accurately and economically takes care of four voltages—using only one meter

Contacts Handle end		Positions 4	3	2	1	Off
1 2	1				X	
	2		X			
3 4	3			X		
	4	X				
5 6	5				X	
	6		X			
7 8	7			X		
	8	X				

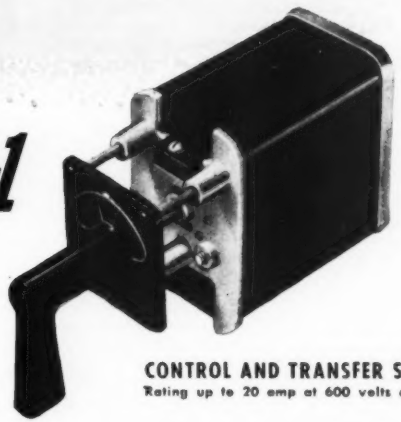
This contact diagram provided an easy way to specify the exact circuit-sequence combination



Operator's panel of a new combined corrugating and double facing machine. The 4-position SB-1 switch makes possible fast readings of critical voltages

...easily done with the SB-1

Standard parts and the simple basic design of the SB-1 mean longer life and low initial cost to you. There's a *standard* SB-1 for most jobs, and they're ready on six weeks delivery. A variety of attractive switch handles, and watertight, dust-tight, oil-immersed, fabricated metal, or explosion-proof housings are available to fit your particular installation problems. Why not try an SB-1 on your particular control problem? For further details see your G-E sales representative and write for Bulletin GEA-4746. *Apparatus Dept., Section B856-9, General Electric Company, Schenectady 5, N. Y.*



CONTROL AND TRANSFER SWITCH
Rating up to 20 amp at 600 volts a-c or d-c

GENERAL ELECTRIC

20% INCREASE IN PRODUCTION! NO MAINTENANCE SHUTDOWNS!

It's made of Nickel-Clad Steel

(*Left*) Fabricating a hydrapulper for Dilts Machine Works, Fulton, N. Y., Div. of Black-Clawson, Inc., Hamilton, Ohio, in the plant of Smith & Caffrey Co., Syracuse, N. Y. (*Right*) Installed hydrapulper, showing Lukens Nickel-Clad Steel on tub sides and bottom plates surrounding the rotor; in use at National Paper Corporation, Ransom, Pa.

Self-cleaning and corrosion-resistant properties of Lukens Nickel-Clad Steel for hydrapulpers make an important contribution to their excellent service records. The above hydrapulper has been in service at the National Paper Corporation, Ransom, Pennsylvania, for more than 16 months without a shutdown for maintenance.

In operation, the work-polished walls of Lukens Nickel-Clad Steel, with the cladding on the inside, require no sluicing down, in contrast to the former type tubs which required at least one sluicing per four fills. This factor was the major contribution in increasing the machine's output approximately 20 per cent. In addition, there is no metallic pick-up to impair the quality of tissue made from furnish produced here.

Lukens Clad Steels—Nickel-Clad, Stainless-Clad, Inconel-Clad and Monel-Clad—provide *solid* corrosion-resistant metal protection at the lower cost of *clad* steels. 10% or 20% of total plate thickness suits most applications. Lukens offers the most complete range of clad steels available from any source; $\frac{3}{16}$" to over 3" thick, or as wide as 178".

Bulletins 255 and 338 give information which will help you adapt Lukens Clad Steels to your equipment. For copies, write Lukens Steel Company, 405 Lukens Bldg., Coatesville, Pennsylvania.

CLAD METAL STEEL

LUKENS

Nickel-Clad Stainless-Clad
Inconel-Clad Monel-Clad
STEELS

Two 16mm Kodachrome motion pictures—"The Manufacture of Lukens Clad Steels" (silent) and "Solving Corrosion Problems" (with sound)—will be loaned to you. Write for booking date.

SOLID METAL ADVANTAGES WITH CLAD STEEL ECONOMY

• • SPEED SCRAP TO THE MILLS TO MAKE MORE STEEL • •

LOOK FOR THE PLASTICS DOLLAR

Monsanto's way of showing you get more for your money by using Monsanto Plastics

While metal prices go higher and higher, supplies get shorter and shorter, *Monsanto plastics are available in unrationed supply at prices lower on the average than in 1940.* Monsanto plastics speed production, cut costs and boost sales—giving manufacturers everywhere a bigger dollar's worth.

Remember: Intricate parts are molded from Monsanto plastics in fast, one-shot operations. Blanking, stamping, punching and machining are all eliminated. And valuable hours of assembly time are saved.

Remember, too—expensive finishing steps are eliminated. No painting, baking or tumbling is necessary—color and finish are inherent. A rainbow range of colors both clear and opaque are available.

Check off these facts, too. Monsanto plastics—the broadest in the industry, including thermoplastics, thermosetting molding compounds, industrial resins and surface coatings, cellulosics, vinyl materials, adhesives and glues—are light weight, rust-proof and durable; and offer a wide range of superior physical properties, e.g., high dimensional stability, heat resistance, excellent resistance to alkalies, acids and water. Use the coupon to receive the interesting booklet, "What Monsanto Plastics Can Do For You" and feel free to write us about any specific problem.

MONSANTO
CHEMICALS FOR PLASTICS

MONSANTO CHEMICAL COMPANY, PLASTICS DIVISION
Dept. PEP14 Springfield 2, Mass.

☐ *Please send me the 20-page Monsanto booklet.*
☐ *Please send me information on plastics for use in* _____
(type of product).

Name _____ Title _____
Company _____
Address _____
City _____ Zone _____ State _____

SERVING INDUSTRY . . . WHICH SERVES MANKIND

It pays to use your custom molder's know-how

Say RCA Victor Engineers

No. 2 in a series on Plastics Skill at Work...

PROJECT: Bezel frame for television kinescope.

CUSTOMER: Radio Corporation of America, RCA Victor Division.

MOLDER: Kurz-Kasch, Inc.

MATERIAL: Heat-resistant Durez phenolic with gold lacquer finish.

SUCCESS INSURANCE: Kurz-Kasch molding specialists pre-sampled and pre-tested all likely materials to make sure bezel would process satisfactorily and not interfere with picture on the receiver. Heat-resistant Durez was recommended ...it proved to be an ideal material.

● RCA Victor engineers were aiming at top performance in developing this popular-priced television set. One step they took to get it points up a good working rule for manufacturers in many fields...*Though you may know "all about" plastics, the counsel of a reputable custom molder is the best kind of success insurance.*

In this case, RCA Victor realized that metal would be less than ideal for the kinescope bezel frame. Cost was against it...as was the tendency to pick up electrical disturbances. So they specified a general-purpose phenolic plastic.

Then Kurz-Kasch, the molder, sampling many materials before going ahead, found that a heat-resistant Durez stood up under paint baking temperatures best of all. Also, being big and thin-sectioned, and having only four corner bosses in line with RCA Victor assembly standards, the bezel required the dimensional stability of this Durez phenolic.

Almost everywhere in industry the know-how of good molders is helping to make better products. Durez too, as leading specialists in the phenolics, can bring broad experience to your new product planning.

Our field engineers are available whenever you say the word.

A new hit with plastics users everywhere is the handy "Durez Check-Chart." Write for yours. Durez Plastics & Chemicals, Inc., 152 Walck Rd., N. Tonawanda, N. Y.

DUREZ

PHENOLIC RESINS

- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
- PROTECTIVE COATING RESINS

PHENOLIC PLASTICS THAT FIT THE JOB

WESTINGHOUSE GEARMOTORS

NOW AVAILABLE FROM STOCK

Type E
Double-reduction

Type C

YOU CAN BE SURE..
IF IT'S Westinghouse

Type A
Single-reduction

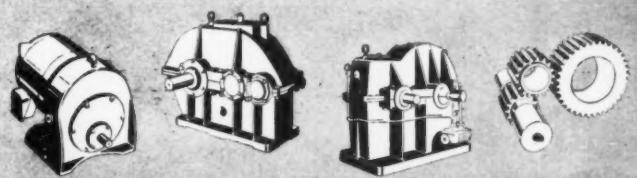
WESTINGHOUSE NOW OFFERS IMMEDIATE DELIVERY ON POPULAR SIZES AND TYPES

Westinghouse Gearmotors are today's best answer for obtaining speed reduction on drive applications from 1 to 75 hp. And now, Westinghouse offers immediate delivery from stock. More than 50 sizes and types are available, comprising commonly used designs, and a few units with special auxiliary features. Many are powered by the revolutionary new Life-Line motor . . . the greatest advance in motor design in 58 years. Call your nearby Westinghouse representative for details on gearmotors available to fit your needs. Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

J-07273

Westinghouse

RPM

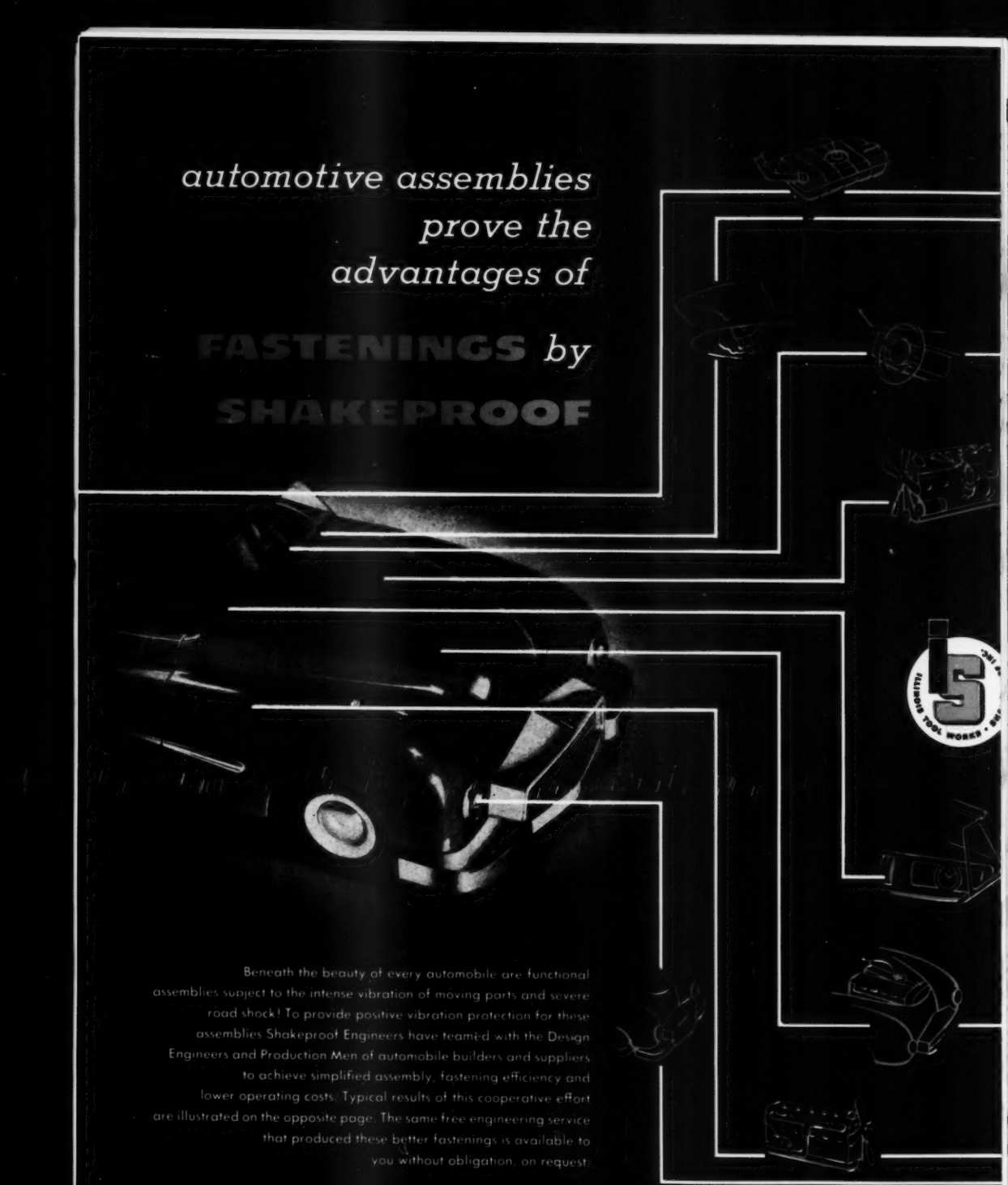


GEARMOTORS • SPEED REDUCERS • SPEED INCREASERS • INDUSTRIAL GEARING

automotive assemblies prove the advantages of

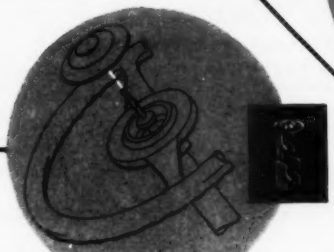
FASTENINGS *by*

SHAKEPROOF

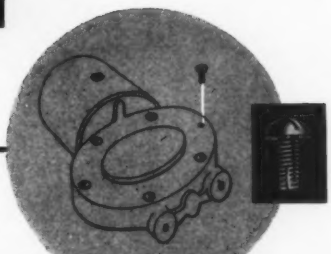


Beneath the beauty of every automobile are functional assemblies subject to the intense vibration of moving parts and severe road shock! To provide positive vibration protection for these assemblies Shakeproof Engineers have teamed with the Design Engineers and Production Men of automobile builders and suppliers to achieve simplified assembly, fastening efficiency and lower operating costs. Typical results of this cooperative effort are illustrated on the opposite page. The same free engineering service that produced these better fastenings is available to you without obligation, on request.

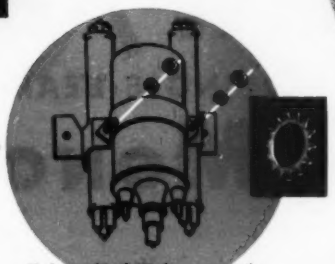
SEMS-by-SHAKEPROOF mount gasoline gauge components securely.



A troublesome soldering operation is eliminated by this Shakeproof Horn Button Contact Terminal



The windshield wiper worm drive housing cover is held on tightly by Thread-Cutting SEMS-by-SHAKEPROOF.



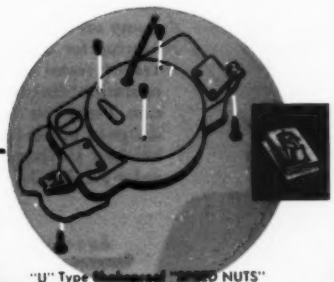
Shakeproof Lock Washers protect the spark coil mounting against vibration loosening.

WRITE FOR SAMPLES...

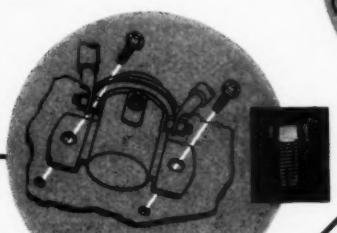
SHAKEPROOF inc.

fastening headquarters

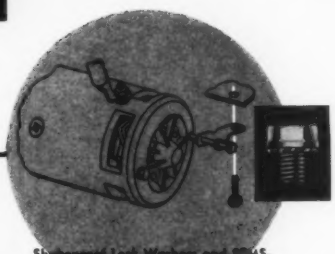
Division of Illinois Tool Works
2501 North Keeler Avenue
Chicago 39, Illinois
In Canada: Canada Illinois Tools, Ltd.
Toronto, Ontario



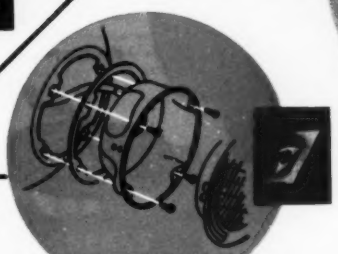
"U" Type Shakeproof "SPEED NUTS" mount the dash clock housing in place.



The vital starter switch mounting is dependable with Indented Hexagon Washer Head Shakeproof Thread-Cutting Screws.



Shakeproof Lock Washers and SEMS-by-SHAKEPROOF lock the starting motor positively in place against vibration loosening.



"J" Type SHAKEPROOF "SPEED NUTS" hold the fender headlight assembly tight under severe vibration.

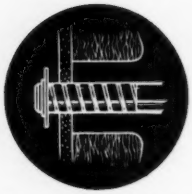
Special inorganic fiber packing . . . high in oil-holding capacity!

Extra large oil reservoir . . . isolated from heat, permanently sealed!

NEW Redmond

SINGLE BEARING, SHADED POLE

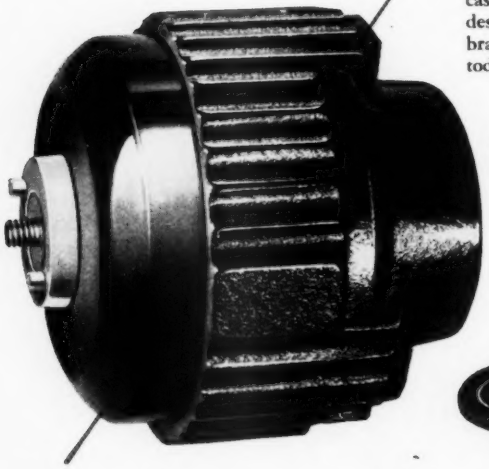
MONOMOTORS



Forced recirculation of lubricant . . . for long, service-free operation!

Precision finished single bearing . . . extra long for true shaft alignment and free running rotor!

Here are the features you want . . . the features you need in single bearing fractional horsepower electric motors. Brought to you now in the new Redmond MonoMotor . . . 4-pole shaded pole, up to 9 watts output. Designed and built to give you outstanding performance over years of smooth, quiet, service-free operation. Look! ☆ Extra large oil reservoir . . . isolated from heat and permanently sealed. ☆ Special inorganic fiber packing . . . dependable oil release, improved lubricating action. ☆ Forced feed lubrication of bearing surfaces by means of spiral pump on shaft. ☆ Extra long, precision finished single bearing for accurate sustained rotor alignment. Then add varnish sealed windings for humidity resistance and cooler operation, die cast aluminum rotor, and a rugged cast iron case. There you have a perfect little low-range power unit designed to out-last your longest expectations. Mounting brackets available, too, for simplified installation. Write today for details.



Redmond COMPANY, INC.
OWOSSO, MICHIGAN

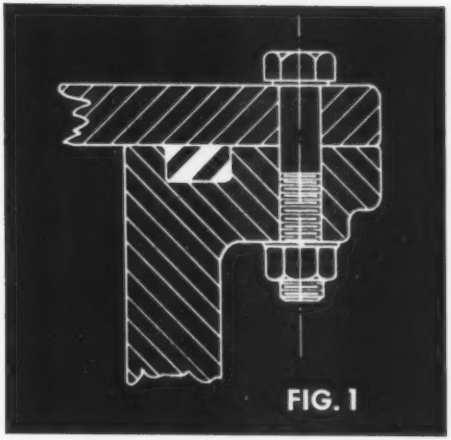
REDMOND ®

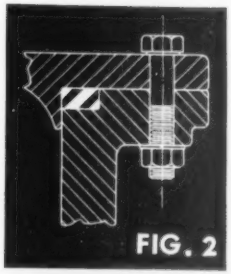
OFFICES IN NEW YORK, CHICAGO, DAYTON, LOS ANGELES, DALLAS

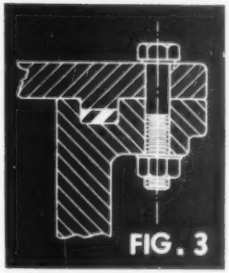
Key to your low-range power requirements.

EXPANDED FACILITIES ☆ PROMPT DELIVERIES ☆ SERVICE BEFORE AND BEYOND THE SALE

Adding compressibility to rubber cuts sealing costs on rigid joints







Effective, low-cost sealing of rigid, metal-to-metal joints calls for a gasket, simple in shape, that will completely fill its recessed channel without requiring excessively close gasket tolerances.

Because Armstrong's cork-and-rubber gasket materials combine the natural compressibility of cork with the sealing properties of rubber, they are ideally suited to this type of application. Most of these cork-and-rubber compositions will compress up to 33% with no appreciable side flow. Hence close tolerances on gaskets are unnecessary. And no relief is needed to accommodate side flow.

To most fluids, cork-and-rubber compositions offer about the same resistance as comparable straight synthetics. And because cork-and-rubber rings can be lathe-cut from tubes, gasket costs on the larger sizes (10" to 20" O.D.) usually are less for these more expensive compounds than would be similar parts die-cut from cork composition sheets.

Figure 1 shows a typical rigid gasketed joint. In such applications, a straight rubber gasket may overflow the channel. Or it may fail to fill the channel sufficiently to provide a tight seal. Cork-and-rubber, on the other hand, permits the use of oversized gaskets that compress into the channel and fill it completely. The absence of side flow makes it easy to mate flanges perfectly.

For the flange shown in figure 2, a cork-and-rubber composition is modified to provide a controlled amount of side flow. Thus, this gasket insures a tight seal against the side as well as the top.

The high pressure flange shown in figure 3 utilizes a stop to prevent blowouts. Perfect mating of flanges is assured with a cork-and-rubber gasket.

We urge you to discuss your applications with your Armstrong representative. Methods and materials he may suggest may help save production time and help reduce costs.

Send for this Gasket Handbook

You'll find useful application and specification data in the new, enlarged 24-page booklet, "Armstrong's Gasket and Sealing Materials." It contains up-to-date data on synthetic rubber, cork-and-synthetic-rubber, cork composition, and fiber sheet sealing materials.

This booklet includes ten technical discussions of the factors influencing modern gasket and joint design. It also suggests methods of putting Armstrong's stock materials to specialized uses in such fields as radio, electrical, automotive, petroleum, and transportation industries. Also included are typical applications and current government specifications.

For your free copy, fill in coupon at right and mail today.

ARMSTRONG CORK CO.
Gaskets and Packings Dept.
7102 Arch Street, Lancaster, Pa.

Please send me at once a copy of the new 24-page booklet, "Armstrong's Gasket and Sealing Materials."

NAME .....
COMPANY .....
ADDRESS .....
CITY ..... STATE .....

ARMSTRONG'S
GASKETS • PACKINGS • SEALS

Announcing... new large-size seamless tubing for tough jobs

If you need large-size, seamless tubing to fight high temperatures, oxidation, corrosion, wear or stress, here's good news.

You can get tough tubing for tough jobs in Monel* . . . or Nickel . . . or Inconel*.

Inco's 4000-ton extrusion press (largest of its kind in the world) regularly produces these durable metals in seamless tubing and pipe up to 9¼" O.D. . . . *almost the diameter of a basketball!*

And *cold drawn* seamless pipe and tubing are now being made in sizes up to 8⅝" O.D.

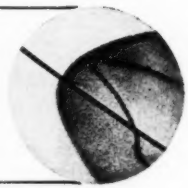
The availability of these metals in such large-size tubing may end one of your present or future problems.

Typical uses for large-size Inco Nickel Alloy tubing include: roller hearths and furnace tubes for strand annealing; bright annealing muffles; radiant tubes; submerged heater tubes; table rolls on paper machines; sleeves for shafts; pump lines; run-down tubes for fractionating towers and many other jobs in the chemical field.

LOOK OVER YOUR TUBE NEEDS. *Whether you're specifying tubes for new equipment or replacing tubes in old installations, consider the many advantages of long-lasting Monel, Nickel and Inconel. They're the "task metals" of industry, ready to take on the tough jobs that ruin ordinary metals.*

SMALL AS A FLY'S VEIN!

You can get Inco Nickel Alloys in small sizes, too. Here's the world's smallest metal tube, shown against the veins in a fly's wing. It's made of Nickel; the O.D. is 0.0014". Commercially, Inco Nickel Alloy tubing is available down to 0.010" O.D.



THE INTERNATIONAL NICKEL COMPANY, INC.

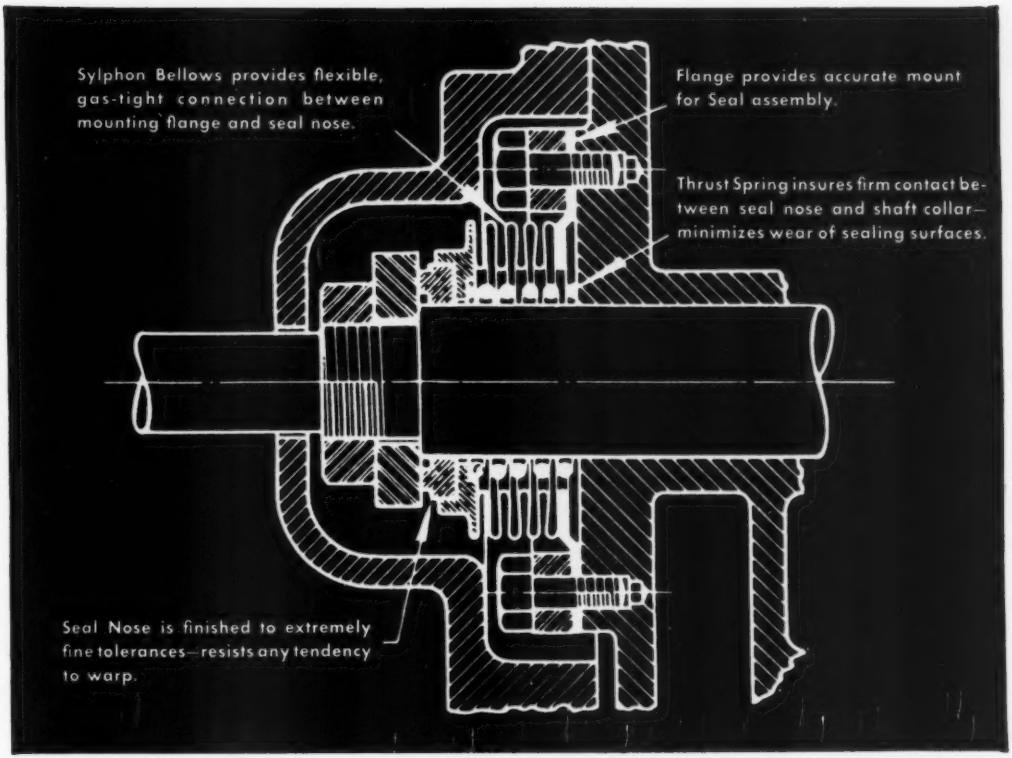
67 Wall Street, New York 5, N. Y.

INCO Nickel Alloys

Monel • "R"* Monel • "K"* Monel • "KR"* Monel • "S"* Monel Nickel • "L"* Nickel • "Z"* Nickel • Inconel* • *Reg. U.S. Pat. Off.*

"Task Metals" for Industry

EMBLEM OF SERVICE INCO


Sylphon Bellows provides flexible, gas-tight connection between mounting flange and seal nose.
Flange provides accurate mount for Seal assembly.
Thrust Spring insures firm contact between seal nose and shaft collar—minimizes wear of sealing surfaces.
Seal Nose is finished to extremely fine tolerances—resists any tendency to warp.

No leaks, no losses, of gases or liquids . . .

. . . with SYLPHON SHAFT SEALS

You can depend upon Sylphon Seals to eliminate leakage of gas or liquid around a rotating shaft . . . surely, safely, economically. They're engineered *on order*—designed for specific applications. The sealing surfaces are finished flat and smooth to assure completely satisfactory performance. • Sylphon Shaft Seals are used successfully in refrigerators, pumps, compressors, speed reducers, hydraulic transmissions, washing machines, and many other applications. Precision-built and quality-made to withstand pressures up to hundreds of pounds. For complete information, send for Catalog CB825, or ask for helpful engineering service on your sketches or specifications.

FS

FIRST WITH BELLOWS

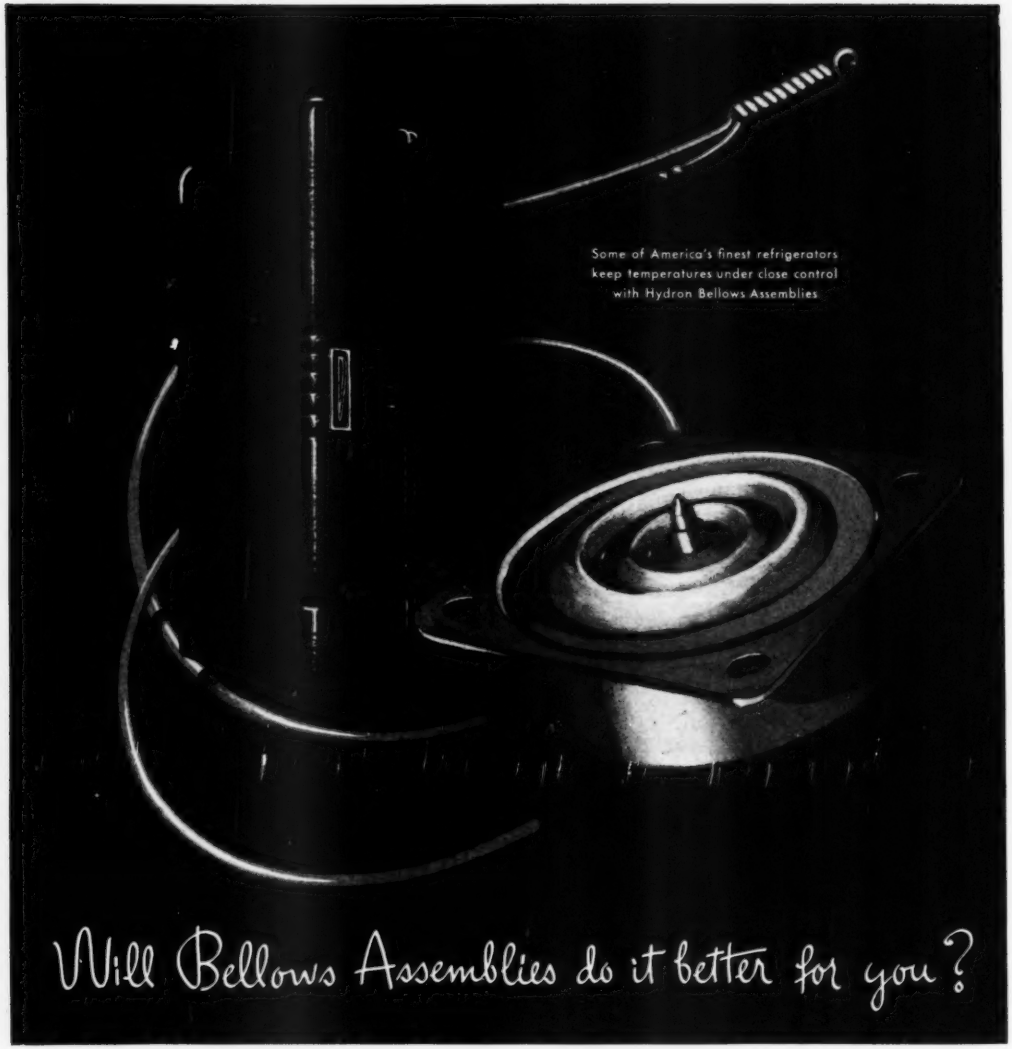
Temperature Controls • Bellows Devices • Bellows Assemblies

FULTON SYLPHON

DIVISION

ROBERTSHAW FULTON CONTROLS CO., KNOXVILLE 4, TENN.

Canadian Representatives, Darling Brothers, Montreal


Some of America's finest refrigerators keep temperatures under close control with Hydron Bellows Assemblies
Will Bellows Assemblies do it better for you?

Many other firms looking for better ways to control temperature or pressure, to seal shafts or valves against leakage, or to transmit motion, have turned to bellows assemblies. Investigation before your designs are too far advanced may pay you, too. Let our engineering department make a confidential analysis of your sketches and specifications and make a recommendation. No obligation, of course.

CLIFFORD MANUFACTURING COMPANY, 564 GROVE ST., WALTHAM 54, MASS. *Division of Standard-Thomson Corporation.* Offices in New York, Detroit, Chicago, Los Angeles.

HYDRON

CLIFFORD

HYDRAULICALLY-FORMED BELLOWS AND BELLOWS ASSEMBLIES

ALL-ALUMINUM OIL COOLERS FOR AIRCRAFT ENGINES

NATIONAL OIL SEAL LOGBOOK

CHARACTERISTICS AND LIMITATIONS OF SPRING-LOADED LEATHER OIL SEALS

The broad applicability and outstanding performance of the single-member spring-loaded leather oil seal has made this design the most widely used of all oil seals. Together with a similar design in synthetic rubber, these single-wipe seals account for more than 80% of all seals used today.

There are three important reasons why spring-loaded leather seals have proven so successful in a wide variety of applications:

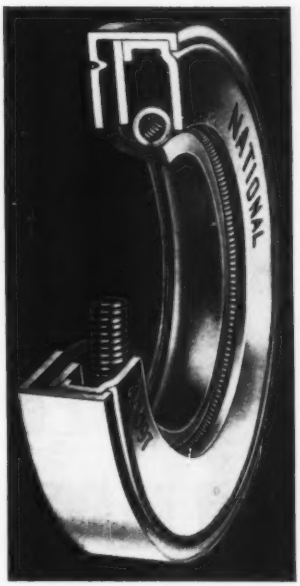
1. **They seal effectively on relatively rough shafts.**
2. **Permit wide tolerance in shaft size.**
3. **Operate well under oil starved conditions for long periods.**

The spring-loaded leather seal is limited in operation as to speed (2000 FPM); temperature (200° F.); pressure (20 lbs. psi), and run-out (.010 indicator reading). However, the spring-loaded leather seal is virtually the only design that provides good protection on rough shaft surfaces . . . up to 65 RMS with low leakage. This same inherent characteristic also permits a wide latitude in the machining of shaft diameters—an important advantage in high speed production of equipment.

A distinct advantage of the spring-loaded leather oil seal is its rugged construction. Such seals, particularly the 50,000 series National Oil Seal (illustrated), are built with a heavy cross-section. This allows the seal case to withstand hard knocks during assembly, and provides a margin of safety against inexpert replacement techniques in the field.

And, furthermore, because the leather sealing members are porous enough to retain lubricant within themselves, these seals can operate under dry conditions for some time . . . a safety margin against neglect of lubrication.

Single-wipe spring-loaded leather seals are the most completely tooled of all designs, and production quantities are generally available in almost any standard bore or shaft size. Spring-loaded leather National Oil Seals (National 50,000 series) are available from stock in more than 850 different size combinations. For complete information, write direct to factory or get in touch with the nearest National Oil Seal Engineer. (See list below.)



NATIONAL
OIL AND FLUID SEALS

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California
Plants: Redwood City and Los Angeles, California; Van Wert, Ohio

CALL IN A NATIONAL ENGINEER FOR RECOMMENDATIONS

BUFFALO: 56 Arlington Place, Grant 2280. **CHICAGO:** Room 2014 Field Building, Central 6-8663.
CLEVELAND: 210 Heights Rockefeller Building, Yellowstone 2720. **DALLAS:** 30½ Highland Park Village, Justin 8-8453.
DETROIT: Room 1026 Fisher Building, Trinity 1-6363. **HOUSTON:** 6731 Harrisburg Boulevard, Wayside 3-1246.
LOS ANGELES: 2244 East 37th Street, Kimball 6384. **MILWAUKEE:** 1717 E. Kane Place, Lakeside 2838.
NEW YORK CITY: 122 East 42nd Street, Lexington 2-8260. **PHILADELPHIA:** 401 North Broad Street, Bell-Walnut 2-6997.
REDWOOD CITY, CALIF.: Broadway and National, Emerson 6-3861. **WEST SPRINGFIELD, MASS.:** 1025 Elm Street, Springfield 2-1881.
EAST SYRACUSE, N. Y.: 226 Roby Avenue, East Syracuse 366. **WICHITA:** 340 North St. Francis Street, Wichita 2-6971.

SKINNER

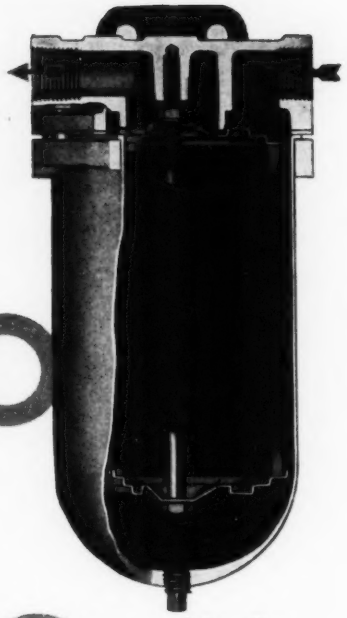
1 *High Flow Rate*

2 *Low Pressure Drop*

3 *Higher Filtration Efficiency*

4 *No Channeling or Bypassing*

4 POINT FILTERS



AMERICA'S MOST VERSATILE AND EFFICIENT FILTERS FOR INDUSTRY

Automotive

Filters for air, oil, and gasoline—widely used by many of the leading automotive and engine manufacturers.

Aviation

A complete line of aircraft filters for oil, air, kerosene, gasoline, and anti-icing fluid.

Marine

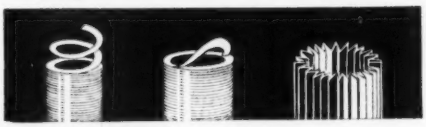
Filters for diesel fuel, oil, and gasoline in sizes to fit nearly every marine engine.

Industrial

A wide range of filters for air, water, petroleum products, and other fluids.

Scientifically designed for highly efficient filtration, Skinner filter elements are constructed of phenolic resin-impregnated cellulose. These Skinner elements are made in three basic patterns and a variety of sizes to fit every industrial filtering operation. They provide positive filtration from ½ micron (.000019") upward, with flow rates as high as 5000 gallons per minute. You can count on Skinner filters to cut operating expenses substantially by reducing wear and increasing efficiency. For manufacturing economy and product protection—install Skinner filters.

Look for these Patterns of Purity



For specific information on *your* particular filtration problem, WRITE DIRECT TO:

SKINNER PURIFIERS DIVISION OF

1500 Trombly Avenue, Detroit 11, Michigan

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, New York

Bendix AVIATION CORPORATION

100,000 Hours

FROM ONE SET OF "SUPER-7" V-BELTS!

OVER 14 YEARS AGO, 66 complete *Texrope* drives were installed in New York's famous RCA building . . . on air-conditioning equipment for the NBC radio studios. Today, some of these *original* V-belts are still running, 20 hours a day, week in, week out!

Texrope drives were selected for two major reasons: First, they are completely noiseless and tend to dampen vibration of other parts. Second, multiple belts offer a greater safety factor, assuring service continuity. Now, after 14 years, a "bonus" of exceptionally long life has been added.

Records like this are one reason why more *Texrope* industrial V-belt drives have been installed since 1925 — when Allis-Chalmers originated the multiple V-belt drive — than any other kind.

Texrope drives offer you the widest selection of V-belt products in industry . . . V-belts, standard, adjustable and variable-speed sheaves, and speed changers.

Send for Pre-engineered Drive Manual — Lists stock components to cover 90% of V-belt drives. See your A-C dealer or District Office, or write direct for bulletin 20B6956. Also in Sweet's.

Texrope Super-7 V-belts result from the cooperative research of Allis-Chalmers and B. F. Goodrich; and are sold only by A-C dealers and offices. *Texrope* and *Vari-Pitch* are Allis-Chalmers trademarks. A 2614

ALLIS-CHALMERS, 1002A SO. 70 ST.
MILWAUKEE, WIS.

Sold . . .
Applied . . .
Serviced . . .

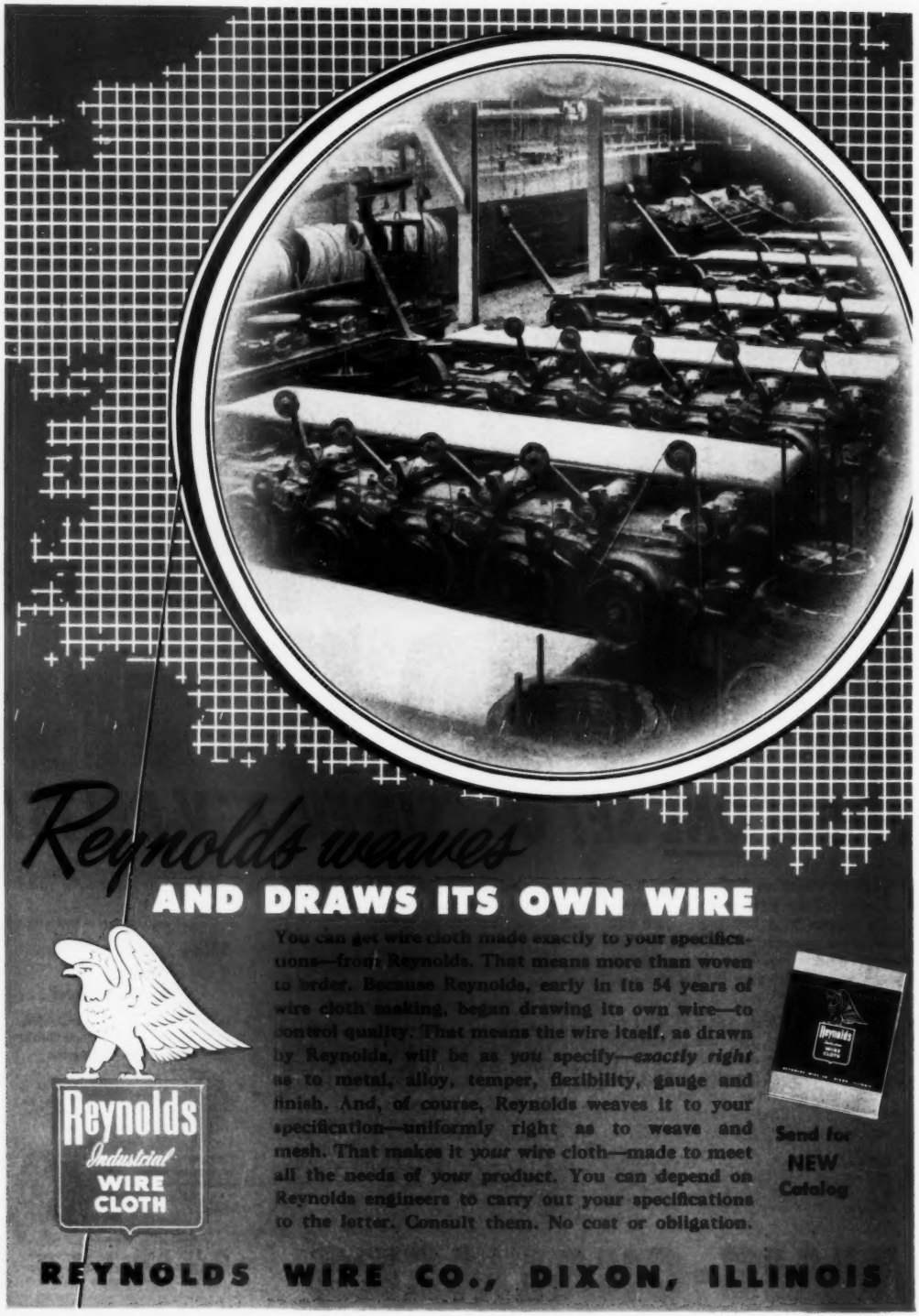
by Allis-Chalmers Authorized Dealers, Certified Service Shops and District Offices throughout the country.

MOTORS — ½ to 25,000 HP and up. Matching Allis-Chalmers Control.

TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.

PUMPS — Integral motor and coupled types. Sizes and ratings to 2500 GPM.

ALLIS-CHALMERS

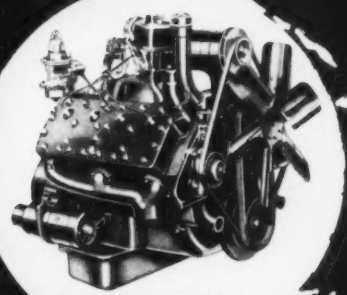

Reynolds weaves
AND DRAWS ITS OWN WIRE
You can get wire cloth made exactly to your specifications—from Reynolds. That means more than woven to order. Because Reynolds, early in its 54 years of wire cloth making, began drawing its own wire—to control quality. That means the wire itself, as drawn by Reynolds, will be as *you* specify—*exactly right* as to metal, alloy, temper, flexibility, gauge and finish. And, of course, Reynolds weaves it to your specification—uniformly right as to weave and mesh. That makes it *your* wire cloth—made to meet all the needs of *your* product. You can depend on Reynolds engineers to carry out your specifications to the letter. Consult them. No cost or obligation.
Reynolds
Industrial
WIRE
CLOTH
Send for
NEW
Catalog
REYNOLDS WIRE CO., DIXON, ILLINOIS

Pick Ford Power-Right 3 Ways

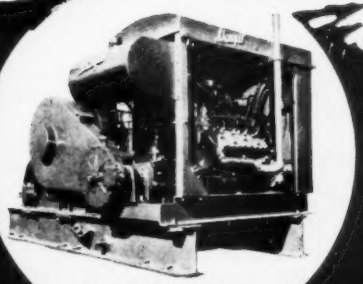
1 RIGHT POWER — for your application, with a choice of five rugged new models now available in the Ford Industrial Engine line.

2 RIGHT FEATURES — all the latest advancements of Ford's "out-front" engineering are incorporated in Ford Industrial Engines.

3 RIGHT SERVICE — as near to you as your Ford Dealer. Operators know that Ford Industrial Engines are always on the job.



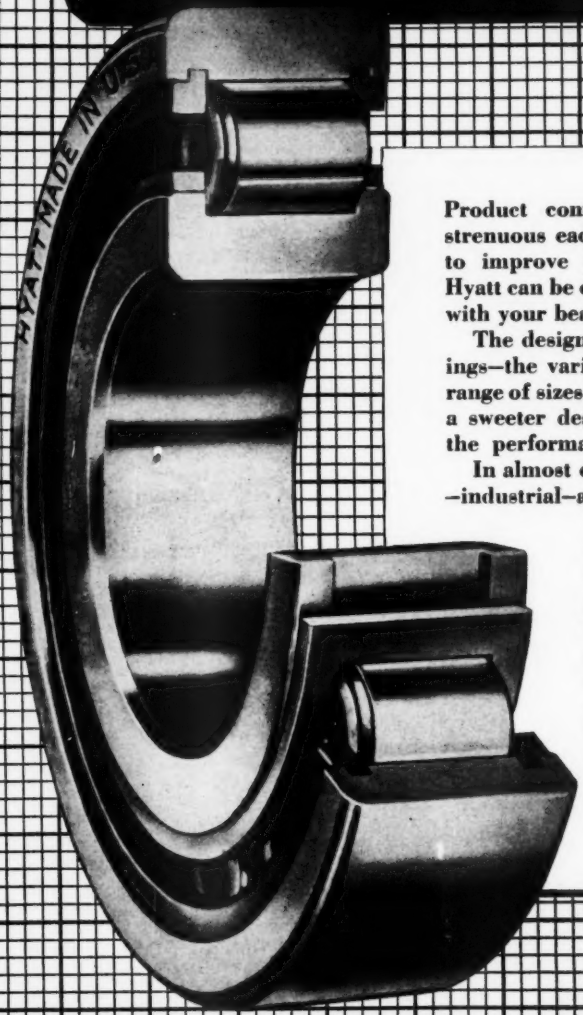
Ford 337 V-8 Industrial Engine (337 cu. in. displacement)



Skagit B-30 logging hoist, using Ford 337 V-8 Industrial Engine.

Ford
INDUSTRIAL ENGINES

A PRECISION PRODUCT for perfect Design

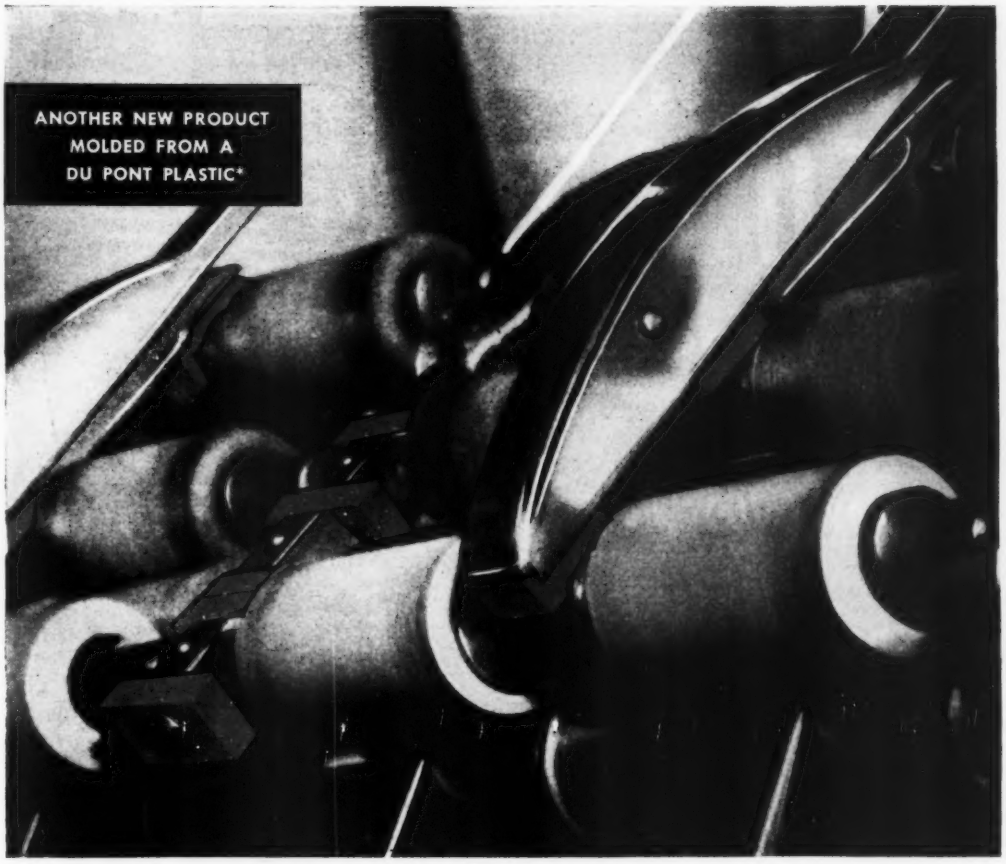


Product competition grows more strenuous each year. In your effort to improve your product design, Hyatt can be of immense help to you with your bearing applications.

The design of Hyatt Roller Bearings—the variety of types—the wide range of sizes enables you to produce a sweeter design that will improve the performance of your product.

In almost every field—automotive—industrial—agricultural—petroleum—steel—textile—construction—transportation, Hyatts have been preferred because each Hyatt is a precision product backed by more than fifty years of acceptance by quality manufacturers. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS



NEW NYLON BEARINGS NEED NO LUBRICATION

Textile-machine parts of Du Pont nylon plastic last for years . . . slash costs

Oil has long been a problem in the making of yarn. In spinning, the yarn is drawn through rollers that stretch and align the fibers. The parts that keep these rollers weighted and in place are called "saddles" and "cap bars." The bearing surfaces of the saddles and cap bars require frequent time-consuming oilings. An average mill may have as many as *135,000 such places to oil* as often as once a day. Frequently, oil gets on the rollers and is transferred to the yarn—necessitating costly cleaning. In addition, the oily rollers pick up lint that must be removed by hand. And when the oil supply on the bearings gets low, the rollers slow down and cause uneven spinning.

But today, yarn makers can solve this problem. For when molded *nylon* bearings replace metal bearings, no lubrication is necessary. They can be installed and practically forgotten. In one textile plant, nylon bearings have been in constant use, without oiling, on all three shifts *for two years . . . and still show little or no wear.*

Big savings result here because use of nylon bearings 1) eliminates oiling, 2) reduces yarn damage, 3) helps maintain uniform yarn quality, 4) virtually ends roll-picking, 5) reduces average power consumption.

This success story is typical of those you'll hear about products molded of nylon. Can nylon plastic solve a problem for you? Write today for helpful facts about this and other versatile Du Pont plastics. Just address E. I. du Pont de Nemours & Co. (Inc.), Plastics Dept., Room 382, Arlington, N. J.

**Saddles and cap bars manufactured by Dixon Lubricating Saddle Co., Bristol, R. I., under the trademark "Slixonice," are equipped with nylon bearings molded by Atlantic Plastics, Inc., Flushing, L.I., N.Y.*

Tune in—Du Pont's famous "Cavalcade of America"—Monday night, NBC coast to coast!

DU PONT
REG. U.S. PAT. OFF.
Plastics
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Records prove the unusual ability of Whitney Roller Chains to withstand shock loads without breakage. A case in point is the following application:—

The head rig drive to the large nine foot Sumner Band Mill at Universal Box Company Ltd. incorporates 3 strand, 1½" pitch, Triplex Whitney Roller Chains for positive transmission of power from the 300 HP synchronous motor. Despite surges in power up to 650 HP (or 350 HP overloads) during the cut run, Whitney Chains withstand these tremendous overloads and are performing day in and day out without failure. In addition to absorbing shock loads, Whitney Chains transmit full rated horsepower without slippage or friction loss. They deliver constant power smoothly and efficiently . . . stand up under the toughest of operating conditions. Write for information.

CHAIN DRIVE IS BETTER

- Positive grip
- Transmits full horsepower
- Simplifies transmission designs
- Low maintenance
- Ease of installation
- Long operating life
- Constant uniform speeds
- High resistance to shock loads
- High load carrying capacity

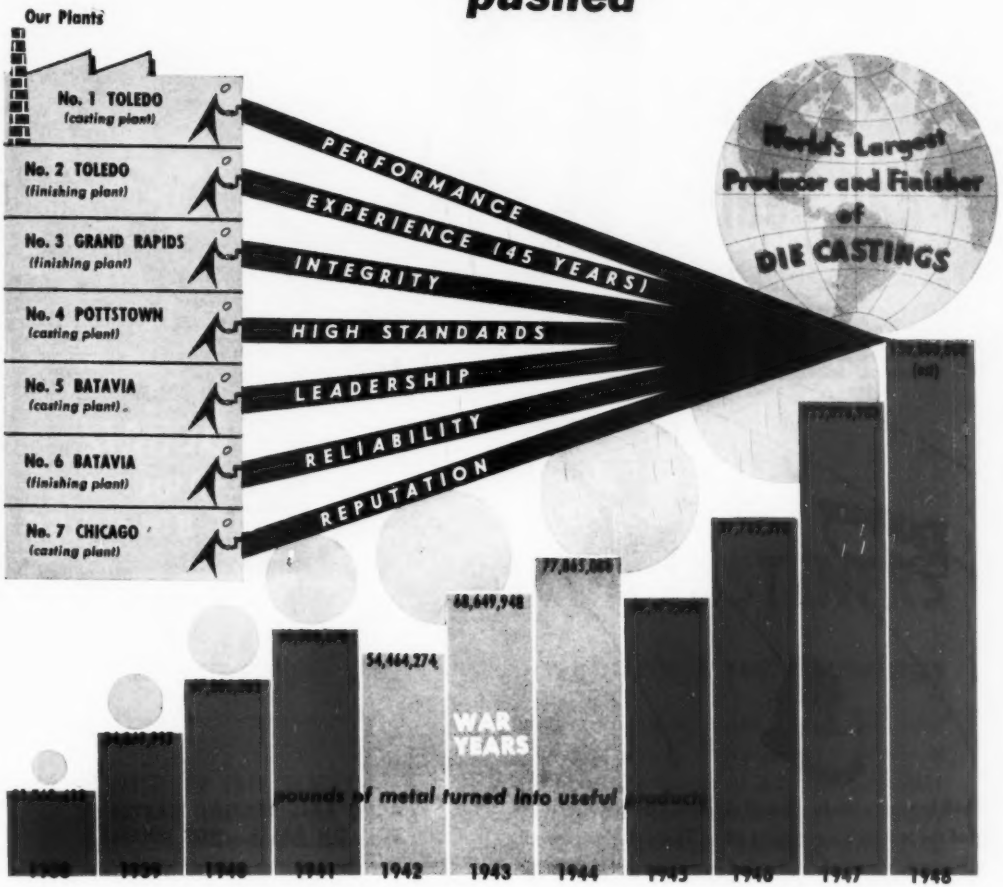
WHITNEY CHAIN & MFG. CO.

Division of Whitney-Hanson Industries Inc.

204 Hamilton Street, Hartford 2, Connecticut

progress doesn't roll uphill

it has to be steadily pushed

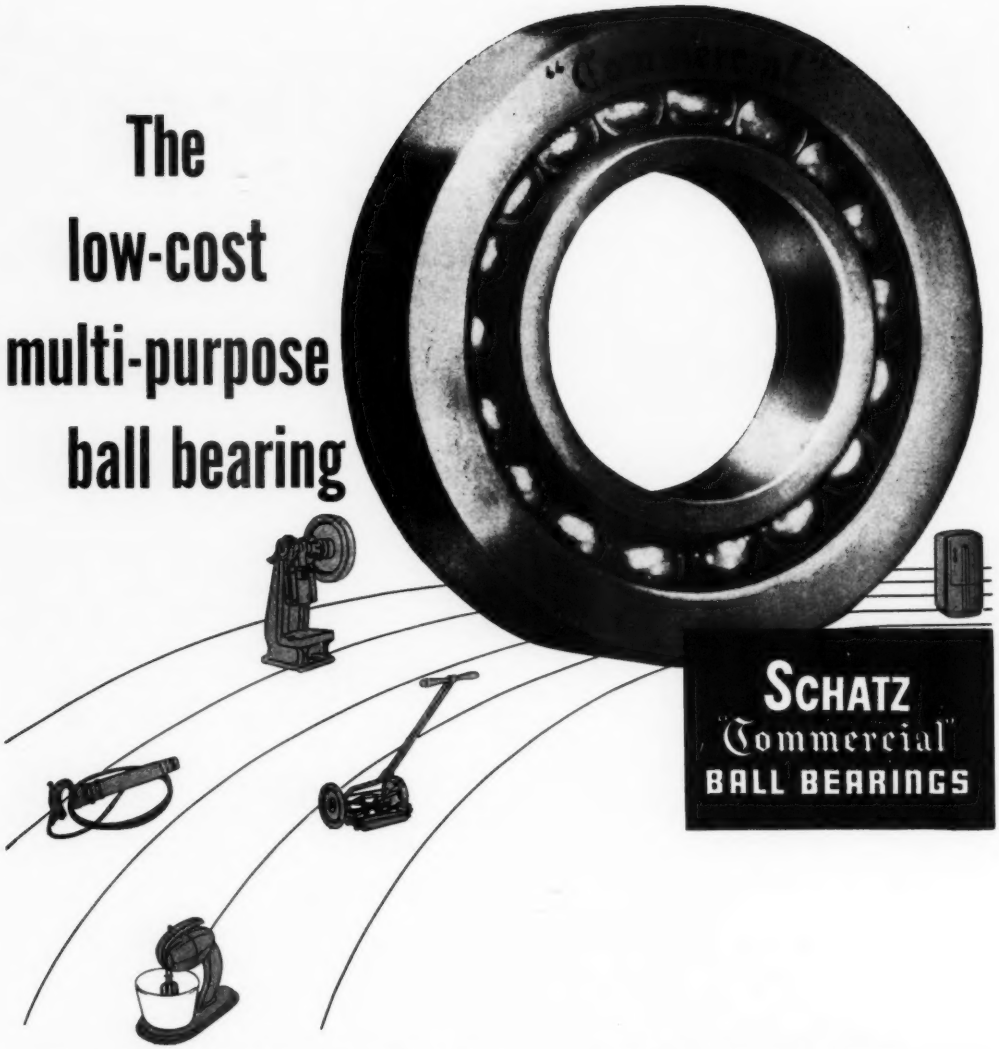


DOEHLER-JARVIS CORPORATION

The World's Largest Producer and Finisher of Die Castings

Executive Office
386 FOURTH AVENUE
NEW YORK 16, N. Y.

The low-cost multi-purpose ball bearing



A ball bearing's life-line is well defined in the physical make-up of the bearing's component parts. That's why you see only carburized, hardened, cold-rolled steel rings and high quality balls in Schatz "Commercials."

High fatigue resistance, added load capacity, and an unusually wide range of applications in stamping presses and lawn mowers or in riveting machines and refrigerators, are the end results.

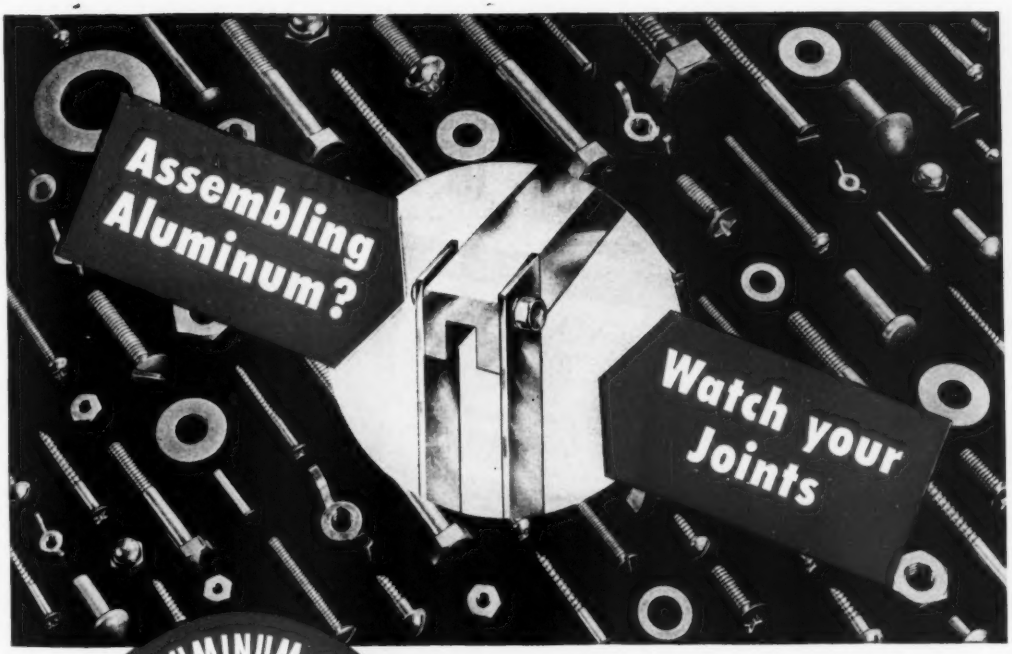
Schatz Bearings are manufactured in every type and size to deliver friction-free performance at low initial cost. Compare their on-the-job performance with other moderate-price bearings. If you have a special bearing problem, our engineers can be helpful in designing a bearing to fit your needs.

ACME BALL BEARING CASTERS
ROLL ON BALLS...NOT WHEELS

Put your conveyors and other industrial machines on Acme Ball Bearing Casters... see how much easier they move in any direction with little effort. They're strong, durable and efficient, and reduce fatigue where heavy equipment is constantly on-the-move.

We can help you adapt Schatz "Commercials" and Acme Casters to your equipment. Why not write now for detailed information?

THE SCHATZ MANUFACTURING COMPANY
6758 FAIRVIEW AVE., POUGHKEEPSIE, N. Y.
REPRESENTATIVES LOCATED AT
2640 Book Tower, Detroit 26, Mich.
402 Swetland Bldg., Cleveland 15, Ohio
8 South Michigan Avenue, Chicago 3, Ill.



SPECIFY ALCOA FASTENERS

. . . *right on your drawings*

Galvanic corrosion can weaken joints—spoil your product's performance—if you assemble aluminum parts with fasteners made of a dissimilar metal! Keep all of the advantages of your aluminum product *throughout*—make assemblies with Alcoa Screws, Bolts and Nuts, or Rivets.

Every type you need is included in the complete Alcoa line. They're strong, good looking, made to Alcoa quality standards. Yet not expensive.

WRITE FOR FREE SAMPLES

of the types that interest you. And phone your nearest Alcoa sales office or Alcoa distributor for prompt service. ALUMINUM COMPANY OF AMERICA, 618 Gulf Building, Pittsburgh 19, Pa.

ALCOA

ALCOA *Aluminum* FASTENERS

SMALL SPRINGS IN A BIG WAY!

Coiled, bent, stamped, formed or punched, your springs can be made by Gibson on speedy, new automatics that eat up mass-production orders. Special equipment for small lots, too. Show us your sample or blueprint for analytical quotation.

SMOOTH ACTING

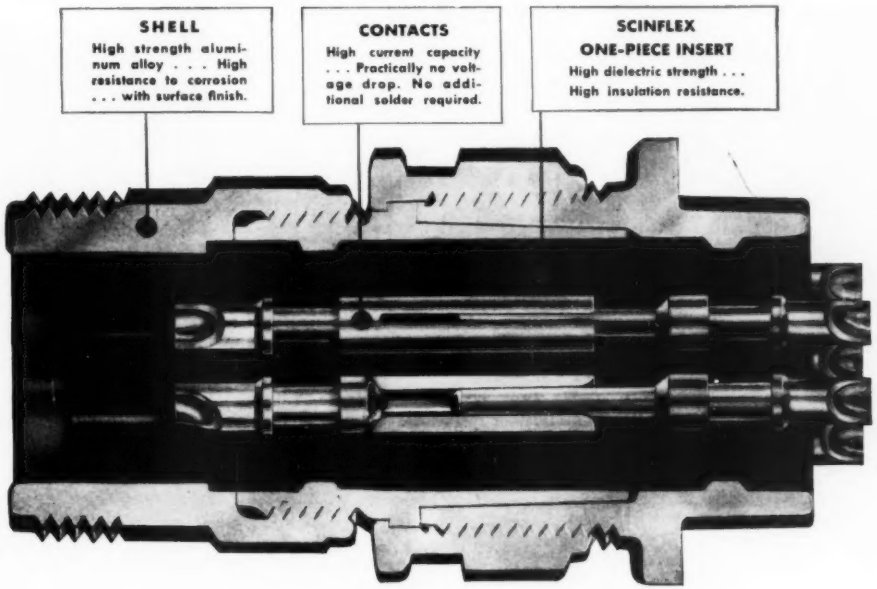
GIBSON-SPRINGS

CLIPS • SMALL STAMPINGS
CLAMPS • WIRE FORMS

The William D. Gibson Co.

DIVISION OF ASSOCIATED SPRING CORP.
1800 CLYBOURN AVE., CHICAGO 14, ILL.

JUST LOOK AT THESE FEATURES . . .


SHELL
High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.
CONTACTS
High current capacity . . . Practically no voltage drop. No additional solder required.
SCINFLEX
ONE-PIECE INSERT
High dielectric strength . . . High insulation resistance.

BENDIX-SCINTILLA

ELECTRICAL CONNECTORS

the Finest money can buy! Contacts that carry maximum currents with a minimum voltage drop are only part of the many new advantages you get with Bendix-Scintilla* Electrical Connectors. The use of "Scinflex" dielectric material, an exclusive new Bendix-Scintilla development of outstanding stability, increases resistance to flashover and creepage. In temperature extremes, from −67° F. to +300° F., performance is remarkable. Dielectric strength is never less than 300 volts per mil. Bendix-Scintilla Connectors have fewer parts than any other connector on the market—and that means lower maintenance costs and better performance.

*TRADE-MARK

CHECK THESE OTHER ADVANTAGES

- Moisture-proof, Pressure-tight
- Radio Quiet
- Single-piece Inserts
- Vibration-proof
- Light Weight
- High Insulation Resistance
- Easy Assembly and Disassembly
- Fewer Parts than any other Connector
- No additional solder required

WRITE DIRECT TO THE SALES DEPARTMENT

BENDIX SCINTILLA

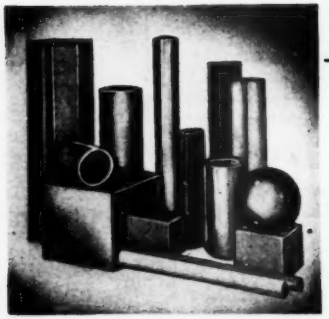
SCINTILLA MAGNETO DIVISION of SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, New York

YOU GET MORE FROM *Catalin*

–AND GET IT FASTER...FOR LESS!



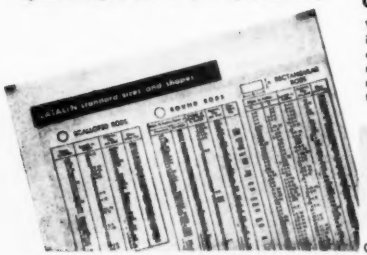
...using stock shapes many applications require only machining and finishing

Catalin Cast Phenolics . . . offer advantages that are product-practical and purse-appealing. Cast and ready in standard shapes, your planning in Catalin travels the *straightest line* between blueprint and completion. Today, with some types of materials being called *short* . . . Catalin is *long* on the strength and satisfaction it can immediately provide.

When quantities are relatively small, Catalin can be fabricated and finished on standard machine shop equipment as easily as brass or wood. In a wide range of colors, and in shapes such as round, square, hexagonal, octagonal and fluted rods of various diameters, as well as cylinders and sheets, Catalin is quickly obtainable from stock in sizes to meet your requirements.

Special shapes, cast to your specifications, are also inexpensive in small and moderate runs when compared to high tooling-up costs for other processes. The use of Catalin does not restrict you as to size or wall thickness. It is also possible to integrally cast two colors in one piece.

The desirable qualities of Catalin Cast Phenolics, in addition to their machinability, include incomparable finish in a clear-through depth of color brilliance. Physically, these thermosetting materials are strong, non-inflammable, resist the action of many chemicals and solvents, and are unusually stable to atmospheric conditions. They possess high compressive, tensile and flexural strengths as well as good electrical and insulating properties.



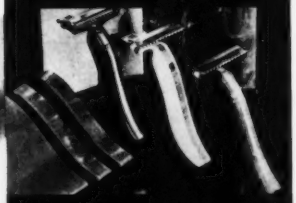
CATALIN HELP BEGINS—AT THE BEGINNING !

With your blueprints as a guide, we can suggest in detail or quote in full. For your preliminary consideration, we will be very happy to send information describing Catalin Cast Phenolics, Styrene molding compounds and Liquid Resins . . . Write today, Dept. PE.

CATALIN
CORPORATION OF AMERICA
ONE PARK AVENUE • NEW YORK 16, N.Y.

Catalin

PLASTICS

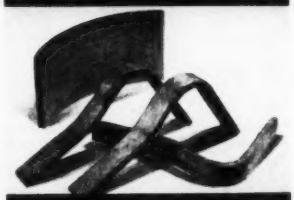


Cast Resins

Catalin Cast Phenolics offer two important advantages to designers and manufacturers . . . a range and depth of gem-like colors, equalled only by semi-precious stones . . . and casting techniques which permit the use of inexpensive, quickly constructed molds with neither size nor thickness limitations. The properties of Catalin are worth investigation.

Molding Compounds

Catalin Styrene injection molding compound enjoys a unique position among plastics. It possesses outstanding electrical, chemical and mechanical properties. It has a "zero" water absorption and is unrivalled in dimensional stability. Catalin Styrene is the lightest weight of all the plastics and one of the least costly. It is available in a limitless range of brilliant colors.



Liquid Resins

"Catabond" and "Catavar" identify a wide variety of thermosetting liquid resin formulations employed in coating, laminating, glueing, bonding and impregnating wood, plywood, abrasives, paper, sisal, glass fibres, leather, cloth, cork, etc. All embody special properties and are designed to do a specific job in some particular industry. There is no evident limit to their useful application.

Monarch lathe with "Air-Gage Tracer" uses Timken® bearings

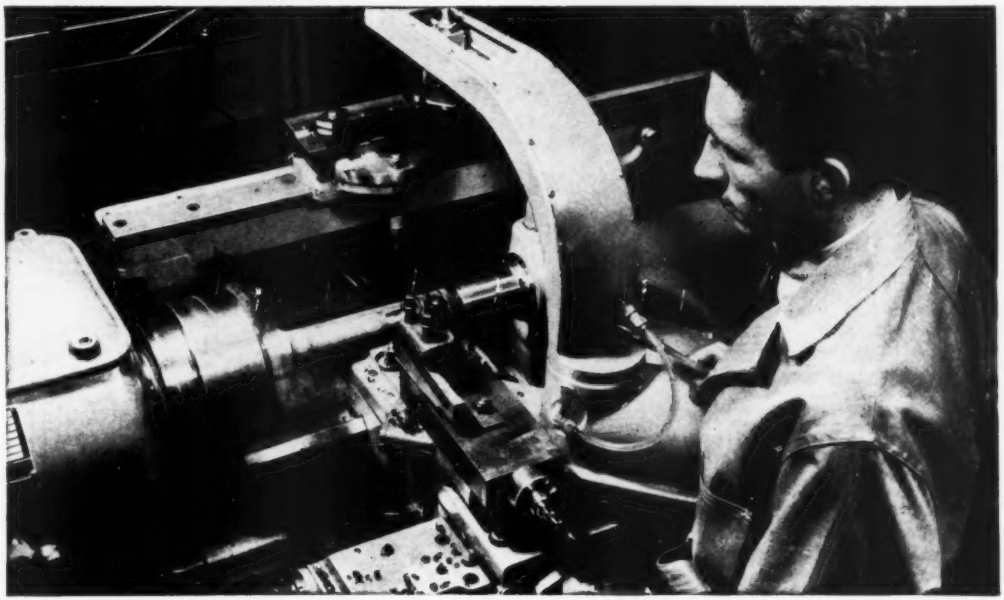
THE sensitive "Air-Gage Tracer", shown fitted to the Monarch 16" lathe below, provides a versatile method of turning multiple diameter shafts and contours from a master template. Contours correspond to the template within a limit of tenths.

Like so many other manufacturers of fine machine tools, Monarch uses Timken tapered roller bearings at vital points. Their tapered construction carries radial and thrust loads without deflection or end-movement, and permits accurate pre-loading to any desired degree. Machine tool spindles are held rigid, kept revolving accurately. Line contact between rolls and races gives unequalled load carrying capacity.

Timken bearings are made from Timken fine alloy steel, heat treated and case-hardened to give amazing resistance to wear. Finishing to incredible smoothness makes friction negligible.

No other bearing can give you all the advantages you get with Timken tapered roller bearings. Be sure you have them in every machine tool you build or buy. Look for the trade-mark "Timken" on the bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

TIMKEN BEARING — *This symbol on a product means its bearings are the best.*



TIMKEN BEARING
CAPACITY RATINGS INCREASED 25%.

Since Timken bearings were re-rated some 15 years ago there has been such a further and constant improvement in quality that we are now able to announce a 25% increase in radial and thrust load carrying capacity. This may make possible the use of smaller bearings with savings in bearing cost, material cost and weight. Engineers will be able to utilize the advantages of Timken bearings in more applications than in the past.

A new Timken Engineering Journal, now in preparation, will give you complete capacity rating tabulations. For further assistance, write us today.

TIMKEN
TRADE MARK REG. U.S. PAT. OFF.
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⬭ AND THRUST ⬭ LOADS OR ANY COMBINATION

new and **important** to you

Here are the advantages to you of Lebanon's new **CENTRI-DIE** casting process—

1. Greater density, resulting in enhanced physical properties.
2. Production of assorted parts and shapes not practicable by static methods.
3. Uniform strength throughout, as no flow lines exist.
4. Production of alloys, difficult or impossible to forge.

LEBANON STEEL FOUNDRY
LEBANON, PA.
"In the Lebanon Valley"

Send for this FREE Bulletin

Write on your business letterhead or fill in this convenient coupon and we will send you a copy of the Bulletin "CENTRI-DIE CASTINGS".

CONTENTS

Centrifugal Casting in Permanent Molds
Advantages of Centrifugal Casting
Various Methods Now Employed
1. True Centrifugal Casting
2. Semi-Centrifugal Casting
3. Pressure Casting
New Developments in True Centrifugal Casting
The CENTRI-DIE Process
English Developmental Work by Firth-Vickers
Lebanon Steel Foundry Obtains Firth-Vickers License
Applications of new CENTRI-DIE Method
Finishing Procedures
Inspection Methods
New CENTRI-DIE Equipment at Lebanon Steel Foundry
General Type Compositions Adaptable to CENTRI-DIE Production

Lebanon Steel Foundry
Lebanon, Pa.

Please send me a copy of your Bulletin L describing the NEW CENTRI-DIE Process of centrifugal casting.

Name.....
Title of position.....
Name of Company.....
Address.....

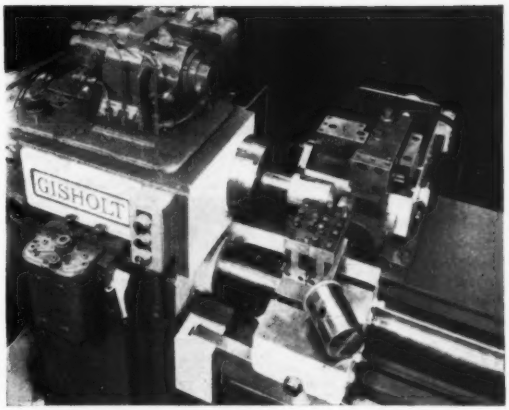
LEBANON *ALLOY AND STEEL* Castings

CIRCLE L

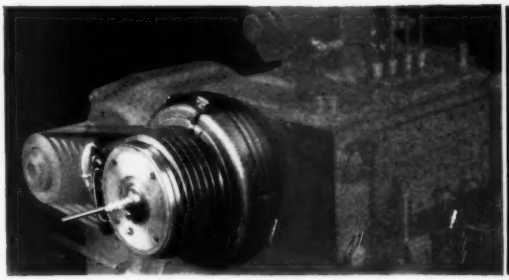
HOW TO DOUBLE PRODUCTION ON AN AUTOMATIC LATHE

-give it a Brake*!

And the Brake to give it is a WARNER ELECTRIC INDUSTRIAL CLUTCH-BRAKE

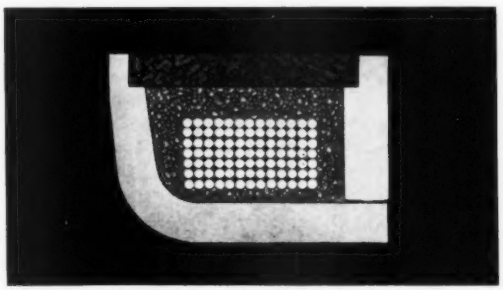


HERE'S HOW Gisholt does it on their No. 12 Hydraulic Automatic. Job: face, turn and cut off the riser on cast aluminum pistons. All starting and stopping of spindle is done by Warner Electric Clutch and Brake Units. Main drive motor is constantly running. Result: faster cycle operation — production doubled from 4 to 8 pieces per minute.



THE WARNER ELECTRIC INDUSTRIAL CLUTCH-BRAKE as mounted on a Gisholt No. 12 Hydraulic Automatic lathe. Note simple, compact mounting arrangement. Both units have only two parts. Ready accessibility of all clutch-brake parts means quick, easy maintenance however seldom required.

ARMATURE SECTION: One of only two parts for either Clutch or Brake units. Consists of magnetic segments welded to steel back-plate (see cut). Especially designed for high heat dissipation. Heat has no effect on unit efficiency because segment expansion is always linear . . . keeps full magnet contact at all times.



MAGNET SECTION: The other of the two parts for either Clutch or Brake units. Consists of electro-magnet faced with long-wearing, high friction material. Power, applied through coils imbedded below (see cut), applies friction *plus* magnetic attraction for fast, super-powerful clutch or brake action.

• Warner ICB Units* are low-cost key to more automatic, safer operation of wide variety of motors and machinery . . . give you infinite control of degree of clutch or brake action. For details or engineering assistance write: INDUSTRIAL DIVISION, WARNER ELECTRIC BRAKE MFG. CO., Beloit, Wis.

*ICB Unit — The trade designation for the Warner Electric INDUSTRIAL CLUTCH OR BRAKE UNIT.

HERE'S WHY NEOPRENE PRODUCTS DO SO MANY JOBS SO WELL

They resist
SUNLIGHT AND WEATHERING—in a class by themselves in resistance to rubber's worst enemies.

They resist
OILS, SOLVENTS, MOST CHEMICALS—set the standard for oil resistance throughout industry.

They resist
ABRASION, CUTTING, CHIPPING—are tough and durable under severe service conditions.

They resist
AIR AND GAS DIFFUSION—have low permeability to gases—retain air longer.

They resist
LOW TEMPERATURE STIFFENING—special compounds retain flexibility at sub-zero exposure over long periods.

FREE! THE NEOPRENE NOTEBOOK—Interesting stories...new, unusual applications of neoprene. Write E. I. du Pont de Nemours & Co. (Inc.), Rubber Chemicals Division B-2, Wilmington 98, Delaware.

Better rubber products are made with Du Pont NEOPRENE

for example:

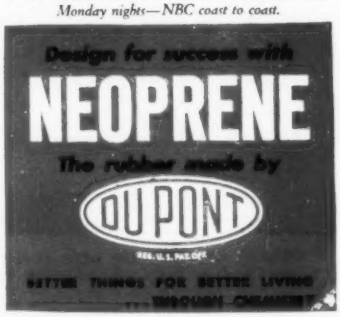
Neoprene packing rings in pipe coupling resist oils, gasoline and heat of welding

The Saftyweld* Coupling is designed to join oil pipe-line sections quickly and securely. It consists of a steel sleeve with internal grooves into which are fitted neoprene packing rings. To install, the coupling is slipped over the pipe sections to be joined, is clamped in place with set screws; then a special neoprene compound is forced behind the packing rings at the pressure connections. This seats the packing rings against the pipewalls. When this seal is formed, the line can be put into full pressure service at once. Welding can be done immediately or postponed until convenient.

Neoprene was chosen for "Saftyweld" Couplings because it resists oils and gasoline . . . retains a high tensile and shearing strength . . . and resists heat caused by the welding operation.

Perhaps neoprene can help you design or improve *your* products. Write us for complete technical data. Du Pont does not make neoprene products, but we'll be glad to contact your supplier or help you find an adequate source. E. I. du Pont de Nemours & Co. (Inc.), Rubber Chemicals Division B-2, Wilmington 98, Delaware.

Tune in to Du Pont "CAVALCADE OF AMERICA," *Monday nights—NBC coast to coast.*



**Saftyweld—Trade mark of The Standard Oil Company (Ohio). Saftyweld Couplings manufactured and distributed by Clark Goodman Supply Co., Cleveland, Ohio.*

Life-Line

NOW... LUBRICATED for LIFE

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

do away with lubrication costs

FOREVER

Forget old-time ideas about the care and greasing needed to keep motors running!

Life-Line motors now eliminate the time and cost required for lubrication—for life! Life-Line double-width ball bearings are pre-lubricated with a more-than-ample supply of specially-treated lubricant—and factory-sealed to keep dirt out and grease in, for *the life of the bearing.*

Periodic weekly or monthly greasing schedules can be dispensed with. Motors may be installed in inaccessible locations; machines no longer need be disassembled to reach motors for greasing. Winding failures caused by overlubrication, and failures caused by use of improper lubricants, can be prevented.

Multiply these advantages by the number of motors in *your* plant. You'll find they offer new and important savings—in labor costs, in machine down-time, in motor outage costs. Then get in touch with your nearest Westinghouse office today. Most standard Life-Line motors are now available from stock. Others are available on short delivery schedules. Ask for details on your requirements. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

Westinghouse

Life-Line Motors

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

Tough lubrication job?

NOT WITH MOTORS

LUBRICATED for LIFE

It costs money to "baby" electric motors with constant greasing attention, whether it's a few or a few hundred.

That's why Life-Line motors offer new and important savings in plants like this one using 119 Life-Line vertical motor drives, and in any others using a-c motors from 1 to 50 horsepower.

Life-Line motors cut down operating costs every day, every week, they are in service, because they need *no* lubrication—*for life.* Sealed, pre-lubricated bearings insure long life—reduce motor outages caused by overlubrication and underlubrication—reduce machine shutdowns and lost production.

Check your Westinghouse representative today for prices and delivery on your requirements. Standard ratings available from stock—others on short delivery. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-21494

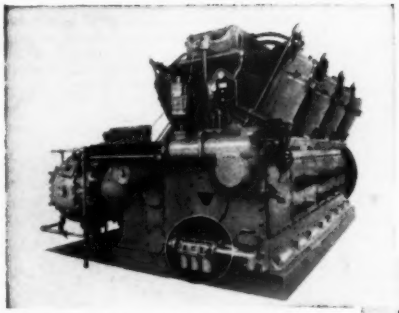
Westinghouse

Life-Line

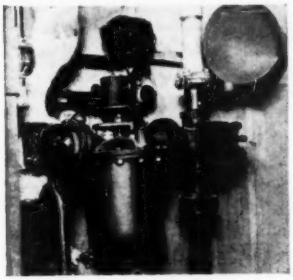
Motors

Litho in U. S. A.

Cleans every drop ...without stop

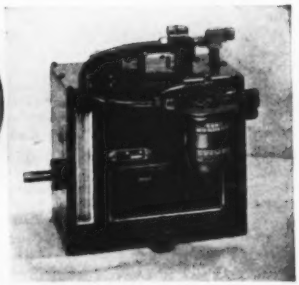


CONTINUOUS CLEANING is why this Diesel manufacturer selected Cuno Auto-Klean Filters as standard equipment. Externally-mounted all-metal filters are cleaned—without stopping flow—by periodic turning of handle.



AUTOMATIC FILTER CLEANING by motor drive is used in this installation where soap is filtered at 300 lb per minute by Cuno Auto-Klean, an application where pressure loss must be minimum.

COMPACTNESS of Cuno Auto-Klean appealed to designers of this high-speed grinder. Built-in cartridge handles full flow of hydraulic system in same space as usual partial-flow type.



POSITIVE REMOVAL not only of metal chips, fine dust, and powder but also of water, from lubricating oil, protects printing presses, special machinery, etc., serviced by this Automatic Lubricator.

Send Coupon

FOR FREE INFORMATION ON *CONTINUOUS CLEANING*

CUNO

Fluid Conditioning

REMOVES MORE SIZES OF SOLIDS FROM MORE TYPES OF FLUIDS

Micronic • Disc-type • Wire-wound • Fabric Filters

Cuno Engineering Corporation
301 South Vine St., Meriden, Conn.

Please send information—without obligation—on Cuno continuous cleaning for application checked.

☐ Lubricating Oil	☐ Water	☐ Coatings and Finishes
☐ Hydraulic Oil	☐ Coolants	☐ Process Liquids
☐ Fuel Oil	☐ Industrial Fluids	☐ Food Products

Name.....Title.....

Company.....

Address.....

PLEASE ATTACH COUPON TO YOUR EUSINESS LETTERHEAD

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by Bridgeport Brass Co. "Bridgeport" BRASS CO. *Headquarters for BRASS, BRONZE and COPPER*

Cold Heading for Precision and Economy

Silicon Bronzes Ideal for This Process

Improved cold heading machines today allow mass production of parts of great strength and precision with minimum material waste and labor costs. These new machines, products of a continued effort to conserve material and reduce manufacturing costs, are claimed to have greater rigidity and accuracy. Increased versatility of such equipment opens a range of work that seems limited only by the ingenuity of the die designer, and the ability of cold heading wire to flow to the desired shapes.

With softer metals, this is no problem. Where the finished part must develop strength of the order of 100,000 psi, however, an unusual combination of ductility and strength is necessary. No mean order, such requirements have been anticipated in non-ferrous metallurgical research.

Bridgeport silicon bronzes, for example, offer the manufacturer high strength in the hard drawn condition combined with remarkable malleability. When properly made from Bridgeport's Silicon Bronze 609, cold upset items do not require heat treatment to relieve stresses. Finished parts are exceptionally strong, resistant to wear and fatigue and free from stress corrosion cracking.

High Strength Fasteners

The most common application is the manufacture of screw products, such as cap and machine screws, bolts, nuts, and components for split bolt connectors. Hard drawn silicon bronze wire with a tensile strength ranging from approximate y 75,000 to 90,000 psi is cold upset without intermediate annealing operations. Threading is generally done by the cold rolling process. Large headed bolts averaging over 100,000 psi are common for most sizes. This value is remarkably high as compared to low carbon steel, and explains the wide acceptance of non-rusting high strength silicon bronzes for such engineering applications.

The versatility of modern cold-heading machines, and the variety of alloys available, make possible production of a wide range of parts. They may range in sizes from tiny rivets to large bolts. Among other items are valve stems, radiator tubes, segment gears and innumerable others. The accompanying photograph illustrates but a few of the many thousands of items that are made.

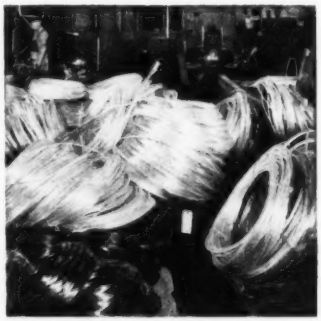
Economy of Manufacture

In cold heading, high production rates are achieved easily. No extra stock need be provided, thus saving material by reducing trim scrap. Threads can be cold rolled, saving machining time as well as scrap loss. Virtually all the metal is used, and the finished cold headed part is often more accurate and stronger than a comparable machined part.

Obviously, quality of the finished part depends as much upon the wire or rod alloy as the machines. Surface imperfections, for example, are magnified greatly by the deformation involved in upsetting large heads. Material with the proper ductility, surface and temper is vital to insure uniform distribution of stock in the finished part and minimum of scrap from breaks in the surface. This is necessary whether head and shank are concentric or offset. Heading wire, therefore, must be more carefully processed from casting to finished size than wire used for other applications.

Aside from silicon bronzes, brass wire alloys are widely used for the manufacture of the many varieties of regular and special screws used in industry, and especially for electrical wiring devices and appliances, as well as for rivets, truck tire valves, valve stems, etc. Brass is an excellent base for lasting and attractive plated finishes, such as nickel and chromium as well as gold and silver for decorative purposes.

The manufacturer who wants to gain the full quality and economy benefits from this method of fabrication can get much help from our laboratories at Bridgeport and Indianapolis. Bridgeport makes a specialty of supplying wire and rod of the proper temper, surface finish and composition for cold heading operations. We will gladly help in the selection of the alloy best suited to specific needs.



Bridgeport makes many cold heading alloys in wire and rod form of the temper, finish and composition needed for high quality and economy of production.

Standard Cold Heading Alloys

A number of alloys of special physical and chemical properties have been developed to meet cold heading needs. Below $\frac{5}{8}$" in diameter, these are generally supplied in coiled material; above that dimension, in rod, to eliminate severe straightening operations.

Silicon Bronze 609 – (Approx. 98% copper, 2% silicon). Especially resistant to stress corrosion cracking. Exceptionally malleable even in hard-drawn condition. Tensile strengths of finished bolts average 100,000 psi. Fine for outdoor use in pole line hardware, wire and cable clamps, water meter bolts and nuts, marine hardware, etc.

Silicon Bronze 609 – (Approx. 98% copper, 1.4% tin, and 1% silicon). Similar in physical properties to alloy #609. Resists season cracking and sea water corrosion.

Phono-Electric 840 – (Approx. 98.6% copper, 1.4% tin). Electrical conductivity approximately 40% that of pure copper. Very malleable – stronger than copper. For pole line hardware and electrical parts where strength, toughness, resistance to weathering and good electrical conductivity are needed.

(Continued on Page 2, Col. 2)

These unusual jobs are produced on two-blow headers. Off-center shapes, odd shapes, and parts requiring uneven distribution of stock and slots are possible on this type of equipment. Courtesy National Machinery Co., Tiffin, Ohio.

CAUSES OF CORROSION

This article is one of a series of discussions by C. L. Bulow, Research Chemist of the Bridgeport Brass Company.

Galvanic Corrosion in Salt Water

Satisfactory Galvanic Couples (Continued)

Silicon bronze bolts used to fasten together carbon steel sections exposed to sea water have led to no measurable increase in corrosion of the steel. Similarly, silicon bronze brazed joints (small area) in relatively large carbon steel sections are also satisfactory.

Silver brazed joints are widely used for joining copper and copper alloy tubing and piping for use in sea water. The results have been uniformly satisfactory.

Silicon bronze welds (made by gas and carbon arc) joining deoxidized copper, red brass, silicon bronze, etc., also show *no* tendency toward increased corrosion due to the galvanic effect in sea water.

Protective Galvanic Couples

Protection by Solder

Coatings of 60 Lead – 40 Tin alloys (soft solder) are commonly applied to copper piping for protection against flowing sea water. It has been reported by Pomfret and Mosher[1] that wiped coatings of solder on copper give considerable protection at low water velocities but *not* at high velocities.

Some years ago it was thought that a dipped tin coating applied to copper or brass condenser tubing would increase the resistance to corrosion from sea water. Experience has shown that such coating is ineffective and this practice has been largely discontinued.

Rupture of the "tin" or solder coating or pinholes in the coating will lead to accelerated corrosion pitting of the copper in rapidly flowing sea water. Here the coating reverses its polarity with respect to the copper and the resulting active galvanic couple consists of a large surface area of a slightly more noble coating and a small anodic area of copper.

Protection by Zinc

Hot dipped (galvanized) and sprayed zinc coatings on steel give protection to the steel as long as some zinc remains. Zinc plates have also been used to protect steel galvanically, etc. The success of this procedure depends upon continuous dissolution of the zinc and a good electrical contact with the steel. Since a high resistance coating forms on the zinc anode which reduces its effectiveness, frequent cleaning of the zinc is necessary.

[1] R. A. Pomfret and L. M. Mosher, Corrosion (N.A.C.E.) 4, 5, 227-43 (1948).

COLD HEADING

(Continued from Page 1, Col. 3)

High Brass 16—(Approx. 65% copper, 35% zinc). Very malleable and ductile, most popular of heading alloys. For machine, wood and cap screws, solid and hollow rivets, special fasteners.

70-30 Brass 37—(Approx. 70% copper, 30% zinc). Slightly more ductile, used for making exceptionally large heads and certain types of hollow rivets.

Low Brass 5—(Approx. 80% copper, 20% zinc). Very malleable, more resistant to stress corrosion cracking and general corrosion. Light golden color—popular for jewelry findings, parts with large upset heads.

Red Brass 85—(Approx. 85% copper, 15% zinc). Very malleable. Good corrosion resistance. Rich golden color. For ornamental jewelry, special rivets and fastenings for vanity cases, lipstick holders.

Commercial Bronze 25—(Approx. 90% copper, 10% zinc). Bronze color, resists season cracking. For fastenings used in outdoor constructions.

Naval Brass 45—(Approx. 60% copper, 0.75% tin, balance zinc). Used for cold heading bolts to U. S. Navy requirements.

Low Leaded Brass 41—(Approx. 63% copper, 0.75% lead, balance zinc). Used where cold heading is followed by drilling, reaming, threading, slotting, and tapping machine operations.

Light Leaded Brass 43—(Approx. 65% copper, 0.3% lead, balance zinc). For operations requiring good cold heading with light machining.

Bridgeport also offers many other alloys in different forms suitable to other fabrication techniques of modern industry.

For fast, precision screw machine production with maximum economy, for example, there are a number of excellent alloys in rod form. These include Duronze* III Aluminum Bronze for exacting engineering applications; High Speed Free-Turning Brass; Leaded Commercial Bronze; Naval Brass and Leaded Naval Brass.

Other mill products include brass, bronze, copper sheet and strip for drawing and stamping; condenser tubing in a wide range of alloys and Duplex tubing; bronze welding rod for fabrication and repairs.

Modern mills in Bridgeport, Conn., and Indianapolis, Ind., with a staff of experienced laboratory and production men, are ready to help you with your metal problems. *Reg. U. S. Pat. Off.

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. None of these items has been tested or is endorsed by the Bridgeport Brass Company. We will gladly refer readers to the manufacturer or other sources for further information.

New Synthetic Enamel Strippers are said to be especially suitable to remove clear synthetic enamels from highly polished surfaces such as brass, gold plate and silver. Non-tarnishing, need not be followed by rinse. **No. 908**

Multiple Fuse contains five fuse links which can be rotated in shell to bring unused link into circuit when one link blows. Inner fuse link unit is replaceable. **No. 909**

New Caulking Material is said to adhere tightly to brass, aluminum, steel, plastics and seal openings and cracks at temperatures between –65° and 500° F. **No. 910**

Two New Cleaning Compounds, supplied as powders for mixture in water in varying proportions depending upon work, are said to clean buffing compounds, oils, dirt from work prior to electroplating. Solution can be used with direct-reverse current cleaning, soak-tank operations followed by reverse current, anodic cleaning and cathodic cleaning. **No. 911**

Die Casting Machine has a cold-chamber hand-ladling head to handle brass, aluminum and magnesium that is interchangeable with a gooseneck plunger and melting pot for zinc, lead and tin. 800-ton pressure, die space 40" to 25" between tiebars, platen movement up to 17½". **No. 912**

New Solderless Terminal, with contact area ¼" x ⅜", combines flat-blade terminal for wiring and female contact member with spring that maintains contact pressure. A dimple and hole prevent accidental disconnect. **No. 913**

Wire Fatigue Testing Machine is said to provide information helpful in controlling wire drawing processes, wire acceptance on basis of fatigue data, predicting wire life in service and determination of safety factors in design. Wire capacity from 0.0005" to 0.030" diameter. **No. 914**

New Metal Forming Process uses dies heated by electric current to neck, seal and upset cylindrical work, which is fed to die and rotated by mechanical and hydraulic pressure. Experimentally, machine has necked 3½" tube with ⅓" wall in 6 seconds. Several capacities from ¾" to 16" diameter. Availability in several months. **No. 915**

Wire-Tying Tool of cast bronze is reported to tighten and tie wire ends in all sizes up to No. 7 in as little as 30 seconds. **No. 916**

Abrasion Testing Machine is said to be useful for testing the abrasion resistance of all types of surface finishes, including electroplate, porcelain enamel, organic coatings, insulating tapes, etc. **No. 917**

Electronic Micrometer makes possible continuous measurements of outside diameter of wire, thread, tubing, rod, etc., and the edge-to-edge dimension of strip stock, etc., at high speed, it is claimed. **No. 918**

BRASS, BRONZE, COPPER, DURONZE, NICKEL SILVER, CUPRO NICKEL

"Bridgeport" BRASS

BRIDGEPORT BRASS

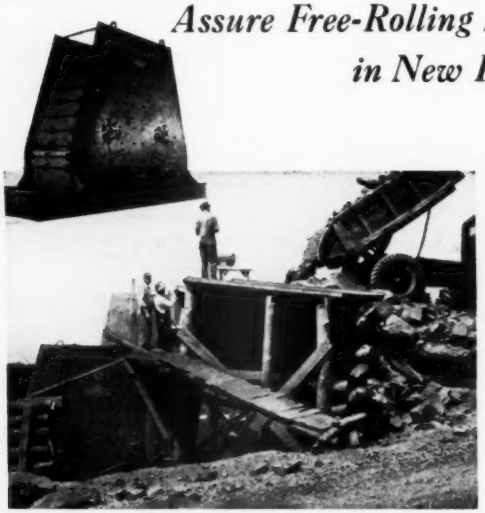
BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN. • ESTABLISHED 1865

Mills at Bridgeport, Connecticut, and Indianapolis, Indiana • In Canada: Noranda Copper and Brass Limited, Montreal

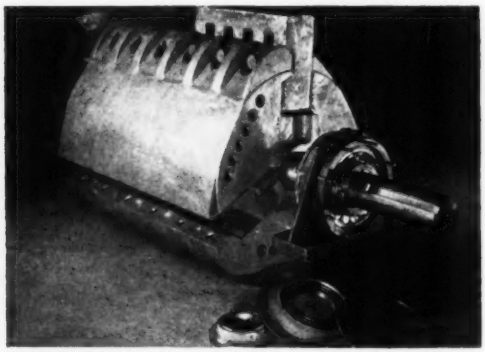
Warehouse Service with Slitting Facilities in Principal Cities

Torrington Spherical Roller Bearings

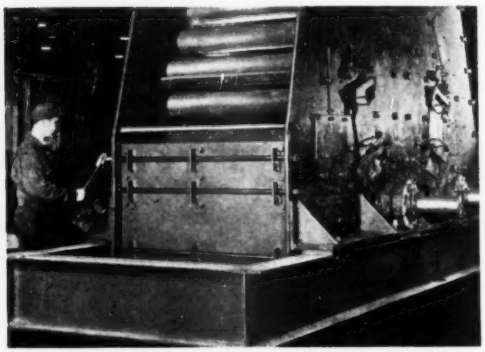
Assure Free-Rolling Alignment, Long Service Life in New Holland Double Impeller Breaker



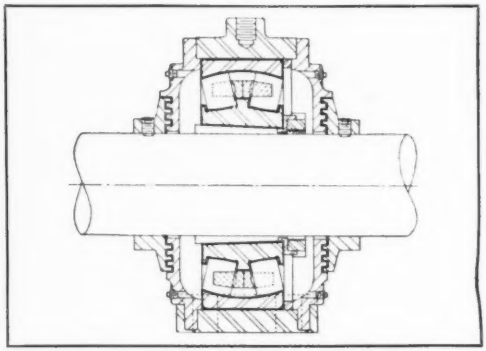
"Two immense rotating impellers are the business end of the Model 5050 Double Impeller Breaker," says Mr. Rollins of the New Holland Manufacturing Company. "Mounted for dependability on Torrington Spherical Roller Bearings, they crush 50-inch stones by a series of impacts applied in suspension."



Ease of assembly and accessibility is assured by the unit design of Spherical Roller Bearings and the simplicity of the pillow block mounting. The bearings carry the 13,400 pound dead weight of the impellers plus the heavy shock loads of operation with an ample margin of safety.



"One of the problems in the design of the Model 5050 Double Impeller Breaker," says Mr. Rollins, "was to secure proper alignment of the impellers on the massive welded frame. The self-aligning feature of Spherical Roller Bearings solved it for us, and there's no worry about shaft deflections in service."



Bearing clearances, vital for precise operation and long service life, can be accurately controlled by the adjustment of tapered sleeves, shown in the cross-section above. Axial stability of impeller shafts is provided by the two-direction thrust capacity of the Torrington Spherical Roller Bearings.

Heavy-duty equipment can be given a long lease on life with Torrington Spherical Roller Bearings. Torrington's engineers offer their specialized experience in every industry to help solve your friction problems. Call or write the nearest Torrington office. THE TORRINGTON COMPANY, South Bend 21, Ind., Torrington, Conn. District Offices and Distributors in Principal Cities.

TORRINGTON *SPHERICAL ROLLER* **BEARINGS**

Spherical Roller • Tapered Roller • Straight Roller

Needle • Ball • Needle Rollers

G-E SILICONE OILS IMPROVE TIMING RELAY PERFORMANCE

Timing motors achieve new efficiency when their time-delay relays are lubricated with General Electric silicone oils. These remarkable oils maintain substantially constant viscosity despite changing operating conditions, remain stable at extremely high or low temperatures.

How G-E Silicones can help you

Could your product, or your manufacturing process, be improved by the use of a chemically inert material with an amazing ability to resist high or low temperatures? If so, you'll want to investigate General Electric silicones.

These materials are available in various forms. There are G-E silicone oils, for example, which flow at 120 below zero F, yet will not ignite at temperatures as high as 570 F. Thus they can be used for applications where extreme heat or cold is a problem, as hydraulic fluids for aircraft, as mold release agents, and as dielectrics. They are ideal damping fluids for automobile motors, and for precision instruments and other controls. And General Electric silicone oils and silicone oil emulsions are finding wide use as mold release agents in the tire and mechanical rubber goods industries.

Then there is G-E silicone rubber, whose elasticity and resiliency at extremes of temperature make it a superior material for oven door seals and vacuum gaskets.

Don't forget G-E silicone *resins*. Their dielectric properties and thermal stability provide unique efficiency in electrical insulation.

WANT TO KNOW MORE ABOUT G-E SILICONES? Tell us about your production problem. Let us help you to solve it with one or more of these amazing, versatile materials. Section 37-2, Chemical Department, General Electric Company, Pittsfield, Massachusetts.

You can put your confidence in

GENERAL ELECTRIC

There's room for your flat work too!

Turning out plain and fancy flat springs and small stampings is a big share of our daily work. Ingenuity with special dies and versatility in the treatment of spring steel in our own mill results in a better product that wins and holds users who rate quality and workmanship high.

For a quotation—or a place on our production schedule—send your inquiries, accompanied by samples and/or complete specifications.

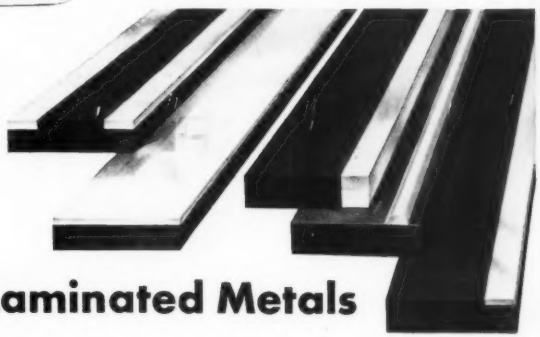
Wallace Barnes SPRINGS

SMALL STAMPINGS • WIRE FORMS • HAIRSPRINGS • COLD ROLLED SPRING STEEL

WALLACE BARNES COMPANY
BRISTOL, CONN.

DIVISION OF THE ASSOCIATED SPRING CORP.

AND IN CANADA, THE WALLACE BARNES CO., LTD., HAMILTON, ONTARIO



Bring them

Down to Earth with

GENERAL PLATE Laminated Metals

The high expense of metals increases fabrication and finished goods prices . . . often to the point that brings customer kick-backs.

You can help keep your costs *down-to-earth* on many parts by using General Plate Laminated Metals. These versatile metals, made by permanently bonding two different types of metals together, give you the combined advantages of both metals.

For example, silver bonded to inexpensive base metal gives you silver performance at a fraction of the cost of solid silver. You can get laminated metals with good conductivity plus extra strength, or corrosion resistance plus rigidity and easy workability.

Manufacturers of electrical, chemical, radio and other equipment are getting better performance at lower cost with General Plate Laminated Metals. Find out how you, too, can save with these versatile metals. Write for information and samples.

GENERAL PLATE DIVISION
of Metals and Controls Corporation
101 Forest Street **Attleboro, Mass.**

MAIL COUPON FOR SAMPLES . . .

GENERAL PLATE DIVISION 1-249
of Metals and Controls Corporation
101 Forest Street, Attleboro, Mass.

Gentlemen:

Please send me information and samples of General Plate Laminated Metals.

Name _____

Title _____

Address _____

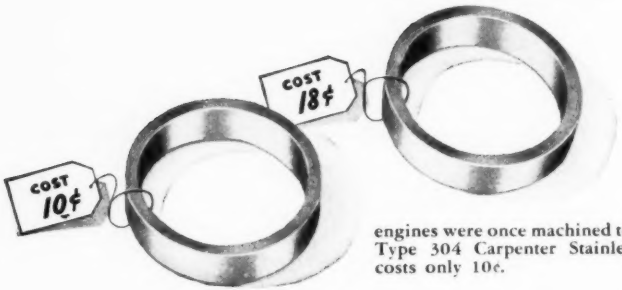
How You Can
CUT YOUR UNIT COSTS . . .

by Changing to *Carpenter* STAINLESS TUBING . . .

Right at the start of your jobs, this Stainless Tubing gives you savings of 15% to 40%.

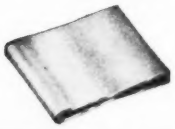
Now add the savings you can make with uniformly good fabricating results on each and every lot . . . fewer rejects and freedom from costly tooling troubles.

Reducing your unit costs on Stainless Tubing jobs is possible today. You can start by calling on Carpenter, just as they did on this valve seat job.

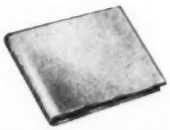


Valve seat inserts for high speed engines were once machined to ± .001" at a cost of 18¢. Now that 2" O.D. Type 304 Carpenter Stainless Tubing is used, each machined unit costs only 10¢.

IMPROVED PRODUCT PERFORMANCE and TROUBLE-FREE FABRICATION start with the Stainless Tubing that passes these tests—



FLATTENING TEST protects you against the possibility of O.D. defects. Specimen is flattened between parallel plates until distance between plates is 3 times the tube's wall thickness. Any sign of cracking or flaws is cause for rejection.

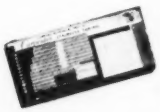


TRANSVERSE BEND is used to double-check the I.D. structure of Carpenter Stainless Tubing. Sample is slit longitudinally and then bent as in the flattening test, but in the opposite direction.

These tests, made at several stages of manufacture, prove quality of the entire tube section and are made on every lot of full finished Carpenter Stainless Tubing before it is released for shipment.

Carpenter
STAINLESS TUBING

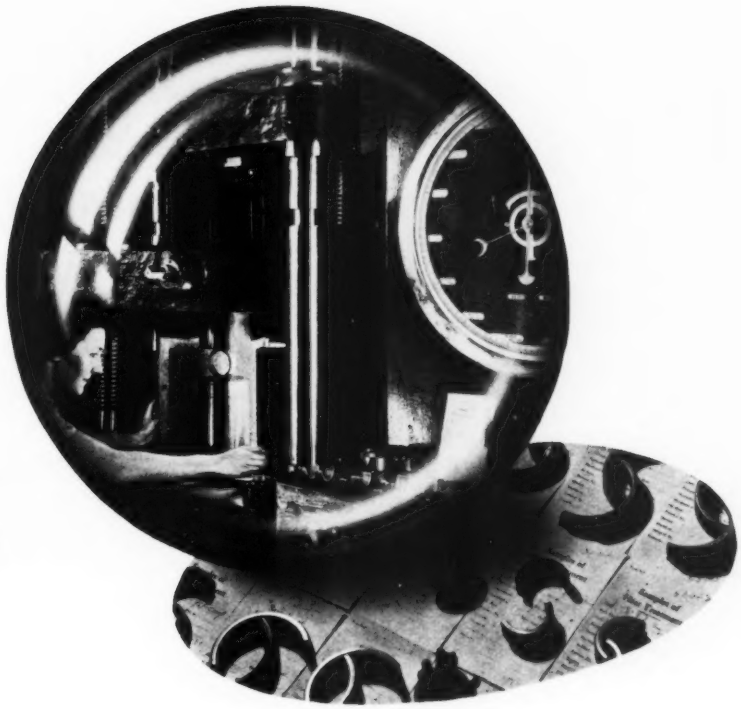
"MORE THAN CORROSION RESISTANCE"



USEFUL SLIDE CHART gives you information that has never before been available in such easy-to-use form. Data on Physical Properties, Velocity Constants, Mass Velocity Constants, etc. A note on your company letterhead will bring your Slide Chart to you.

THE CARPENTER STEEL COMPANY

Alloy Tube Division, 121 Springfield Road, Union, N. J.



Fractured for safety

These bearing parts are part of a day's vital statistics in Federal's "bureau of standards." Here race rings and balls are crush-tested after hardening to determine their load bearing strength, etch tested for any minute cracks in the fracture and Rockwell checked for hardness.

Conditioning a Federal Ball Bearing to deliver the right degree of resilience, toughness and resistance to compression and distortion starts with hardening the race rings *right through to the core* to withstand the severe pressure of the ball on the ball track, particularly under heavy load. Automatic electric controls insure a uniform heat-treat throughout the entire Federal hardening cycle. The silky fracture tells the "inside" story in inspection; performance proves it.

Every fourth operator is an inspector at Federal during the more than 100 individual manufacturing, inspection and cleaning operations that go into every Federal Bearing.

There's a size and type that fits your application in the Federal line. Our Catalogue "K" describes them all May we send you a copy?

THE FEDERAL BEARINGS CO., INC. • POUGHKEEPSIE, NEW YORK

Makers of Fine Ball Bearings

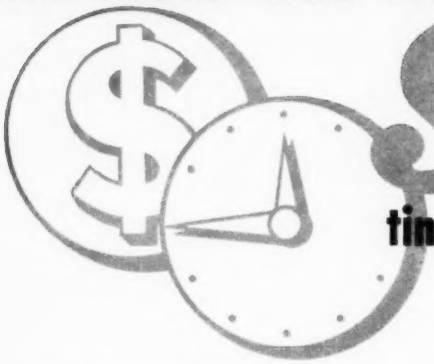
REPRESENTATIVES LOCATED AT

2640 Book Tower, Detroit 26, Mich.
402 Swetland Bldg., Cleveland 15, Ohio
8 South Michigan Avenue, Chicago 3, Illinois

FEDERAL BALL BEARINGS

ONE OF AMERICA'S LEADING BALL BEARING MANUFACTURERS

For those who want to save time and money in reproduction



BRUNING BW WHITEPRINTERS

Bruning Whiteprinters make crisp, clean, black-on-white duplicates of your drawings and documents at a real saving in time and money.

Bruning Whiteprinters copy any Original or Master which is on translucent paper. No intermediate steps to delay you—no films, stencils, or messy inks to buy. No chance of costly errors in transcription. Every BW print is *positive*—a faithful copy of your original.

Bruning Whiteprinters have no special installation costs, there is no cost for darkroom, special wiring, plumbing, or ventilating. They can be installed wherever it is most efficient for you.

You can produce BW prints in any quantity—with the final print as sharp and legible as the first. *And whether you want 1 copy or 1,000—the BW process brings you the same saving on each print.*

Model 41 Bruning Whiteprinter for moderate print production.

CHECK THESE BW ADVANTAGES

Just plug in: Bruning Whiteprinters plug into standard 115 or 230 volt outlets, depending upon the size of the machine. No special wiring required.

No vents or exhaust fans: The BW process is completely odorless . . . BW Prints can be produced anywhere in the drafting room, plant, or office without the slightest offense.

No plumbing connections: There are no pipes to connect, no water to supply or drain away. Nothing to anchor the machine to one spot.

Wide variety of prints: BW prints can be made on light, medium or card weight paper with black, blue, red or brown lines. Also on tinted stocks, transparent paper, film and cloth.

1001 uses: A Bruning Whiteprinter can reproduce letters, invoices, charts, financial reports, or other documents as easily and quickly as it makes perfect prints from engineering drawings. It is truly a company-wide machine . . . saving time and money for every department.

***Send today* for full information.**

Let us send you a file of descriptive literature on Bruning Whiteprinters and BW materials. There is no obligation. It would be helpful to know approximately how many copies you plan to make a day and their average size.

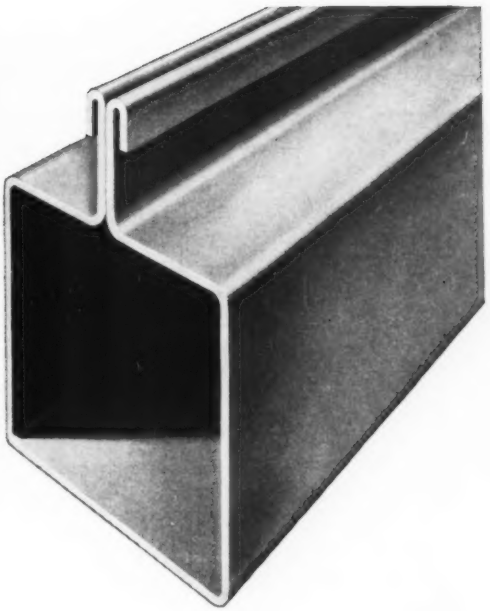
Charles Bruning Company, Inc.

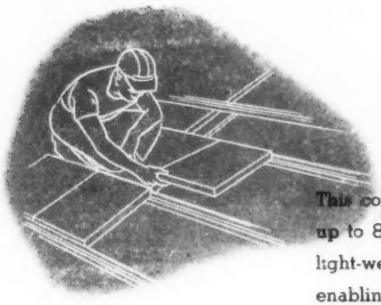
4736-40 West Montrose Avenue, Chicago 41, Ill.

New York - Chicago - Los Angeles - and 12 other cities

Other Bruning products you should know about — Drafting Machines • Drafting Room Furniture • Slide Rules • Erasing Machines • Surveying Instruments • Tracing Papers • Sensitized Papers & Cloth • and many other products.

Roof-Slab Supports Made From Cold-Formed Shapes





This cold-formed shape—a hollow sub-purlin (roof beam) for spans up to 8 ft—is used in the construction industry to support slabs of light-weight roof tile. The purlin rests on steel beams, its long length enabling it to cross several beams. It anchors the tile in place, and because it is light in weight, helps reduce the need for steel framing. We form it cold from 14-gauge strip steel, and supply it in 24-ft lengths.

Sub-purlins, hatch covers, furnace bands, window-frame sections —the range of applications in which Bethlehem Cold-Formed Shapes are being used successfully is wide. And new uses for these versatile shapes are being discovered almost daily.

Bethlehem Cold-Formed Shapes are produced from strip, sheets or plates. They are economical, and uniform in thickness. They also have an excellent strength-weight ratio, and a relatively scale-free surface. We turn them out in all gauges from 7 to 24, inclusive, our specialized shop facilities enabling us to meet virtually every requirement.

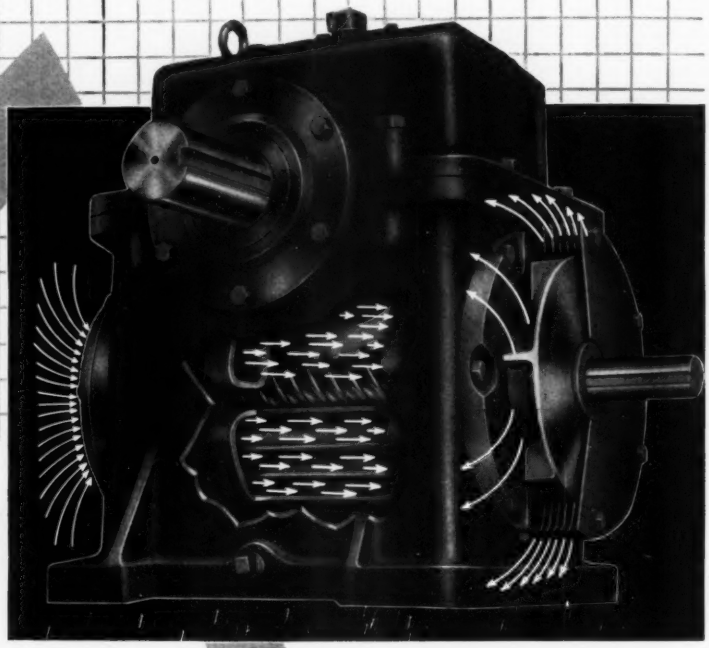
Perhaps you haven't given it much thought up to now, but there may be a place for Bethlehem Cold-Formed Shapes in your business. Why not talk it over with us? If we find the answer is yes, we'll tell you so. And if it's no, we'll tell you that, too.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

Export Distributor: Bethlehem Steel Export Corporation



HOW

TO REDUCE COSTS ON POWER TRANSMISSION

● If you are interested in transmitting power at lower cost, you will be interested in the design and performance of Foote Bros. Hypower Enclosed Worm Gear Drives. Both in design and manufacture, these units represent a new approach to the transmitting of loads. They incorporate greatly improved gearing made possible by a revolutionary new technique in generating gears. An air channel cylinder gives increased thermal capacity, and mechanical capacity has been increased by better metallurgical control of materials.

All these developments, plus improved methods of manufacture, add up to a unit that is smaller in size—lighter in weight—a unit that will save you money in both original and operating cost.

Foote Bros. Hypower Enclosed Gear Drives are made in horizontal and vertical types in a wide variety of sizes and ratios. Write for full information on the Hypower drives, or check with your Foote Bros. representative on any power transmission problem you may face involving any type of gearing or enclosed gear drive.

FOOTE BROS. HYPOWER ENCLOSED GEAR DRIVES

INCREASE LOAD CARRYING CAPACITY

A revolutionary new technique in generating gears gives greatly increased load carrying capacity.

INCREASED THERMAL CAPACITY

One of the features contributing to the increased thermal capacity of these units is an air channel cylinder through which is drawn a stream of air at high velocity. This channel is immersed in an oil bath and has internal fins.

REDUCTION IN SIZE AND WEIGHT

New design and improved methods of manufacture make possible a much smaller reducer and effect a major saving in weight.

BETTER METALLURGICAL CONTROL

Increased mechanical capacity is achieved through improved metallurgical and foundry techniques starting with chemical analysis of virgin metal alloys and carrying this development through to improved production methods.

SEND FOR BULLETIN

Bulletin HPA gives complete information, dimension and rating tables and selection data on Foote Bros. Hypower Enclosed Worm Gear Drives. A copy will be sent on request.

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
Dept. W, 4545 South Western Boulevard • Chicago 9, Illinois

OUTDOOR FURNITURE MAKERS *Can Relax and Rest Easy*

...when their costs are fastened down... and sales speeded up... by AMERICAN PHILLIPS SCREWS

VACATION FROM COST-WORRY: Assembly costs are controlled . . . *fixed and held as much as 50% lower than you ever saw them before* . . . when old-fashioned slotted screws are replaced by modern, power-driven American Phillips Screws, the *only* screws with the crossed, *cornerless* recess. Production and product-quality go up as worker-fatigue goes down. And profits flourish as rejects and spoilage all but vanish.

VACATION FROM SALES-WORRY: Customers *don't* like bungled fastenings with ugly, marred surfaces and broken screw-heads that snag clothes. And that's exactly why they *do* like American Phillips-fastened products . . . because every fastening is cleanly made and attractive to look at, with never a burred head to spoil sales-appeal. So fasten *your* product with American Phillips Screws . . . *and help yourself to double profits.*

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND

Chicago 11: 589 E. Illinois St. *Detroit 2:* 502 Stephenson Building

AMERICAN PHILLIPS *Screws*

ALL TYPES

ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)

At the Heart of every-day living,

Mr. Manufacturer!

WILCO THERMOMETALS (thermostatic bimetals) are at the *heart* of many electrical devices that are at the *heart* of everyday living. They are at the heart of the electric blanket, the room thermostat, gas or electric water heater, the electric toaster and the electric refrigerator. They perform in the carburetor, the cigaret lighter as well as in many instruments of automobiles.

IN MANUFACTURING PLANTS, Wilco Thermometals in circuit control and protective devices (such as circuit breakers, motor starting relays, overload cutouts and voltage regulators) enable production equipment to meet the highest standards of performance. Wilco Thermometals reliably activate mechanical devices, such as automotive chokes, draft controls, gas safety pilots . . . Heating Devices—electric coffee makers, electric flat irons, blankets, toasters, gas and electric ovens, refrigerators . . . Instruments—pressure gauges, demand meters, thermometers, thermostats.

FUNCTIONS . . . Temperature Indication, Control, Compensation, Sequence Control and many others. *Temperature ranges* of maximum sensitivity from —50° to 800° F and a wide range of electrical resistances. Shapes include strip; straight cantilever blades, U-shapes, spirals and helices . . . or as parts of assemblies.

WILCO THERMOMETALS reflect in *quality, precision* and *dependability* the H. A. Wilson Company's 34 years of specialization and outstanding achievement in the metallurgical field. WILCO engineers will gladly help you adapt WILCO products to your individual requirements.

WILCO PRODUCTS INCLUDE: THERMOSTATIC BIMETALS: All temperature ranges, deflection rates and electrical resistivities. ELECTRICAL CONTACTS: Silver, Platinum, Tungsten, Alloys, Sintered Powder Metal. SILVER CLAD STEEL: For industrial use. NI-SPAN C* Constant Modulus Alloy; JACKETED WIRE: Silver or Steel, Copper, Invar and many other combinations. SPECIAL ALLOYS: including high conductivity, high strength Copper Alloys. ROLLED GOLD PLATE AND GOLD FILLED WIRE.

*Reg. Trade Mark, The International Nickel Co., Inc.

THE H. A. WILSON COMPANY
105 CHESTNUT STREET, NEWARK 5, NEW JERSEY
Branch Offices: Chicago, Detroit, Los Angeles, Providence

WILCO
TRADE MARK

Specialists for 34 years in the manufacture of Thermometals • Electrical Contacts • Precious Metal Bimetallic Products and Special Alloys

Keeping in Step With Nature

SUBCONSCIOUSLY OR UNCONSCIOUSLY most decisions are made on the assumption that none of the facts and values involved will change appreciably. Of course, it may be anticipated that certain changes will likely occur, but usually their effects are belittled. Thus have been made the greatest blunders of history and many ghastly mistakes that have led to ruin. The fallacious theories that culminated in the world's worst depression, can be traced to this kind of thinking. It was for the same reason that the guns of Singapore pointed in the wrong direction. That is why Hitler was wrong and Germany was destroyed. And in our business decisions, the failure to recognize the inevitability of change is the greatest factor in causing bankruptcies and drastic stock market swings.

Nothing in the world as we know it is static. No human being is the same on two successive days or even at different times on the same day. The "new look" costume of today becomes the shabby out-of-style raiment of next season. The thrilling movie, the best seller story, the prize winning play and funniest joke get an unresponsive reception when only a few years old. In a normal market a model of previous years can be sold only at a cut price.

Time is a great deceiver because it is constantly and unexpectedly changing things. In the physical world, erosion, corrosion, fire, wind, flood and earthquake unceasingly build or disintegrate mountains, change the courses of rivers, destroy cities, and turn forests into charred tree trunks. In the living world, epidemics spread by germs and invisible forces wipe out populations. People die of starvation because insects have devoured their growing plant foods. Adding to the natural destructions, man contrives fiendish ways to wipe out whole cities in a flash with but few ashes remaining to mark the spot where they stood.

From the littlest things to the biggest, both animate and inanimate, everything is changing unceasingly. We see it, we hear it, we feel it, and we know it. Yet, in spite of all this, the most common human error is to establish convictions and make decisions on the completely false premise that the related factors and conditions will remain constant or at least so nearly constant that the decisions will not be affected.

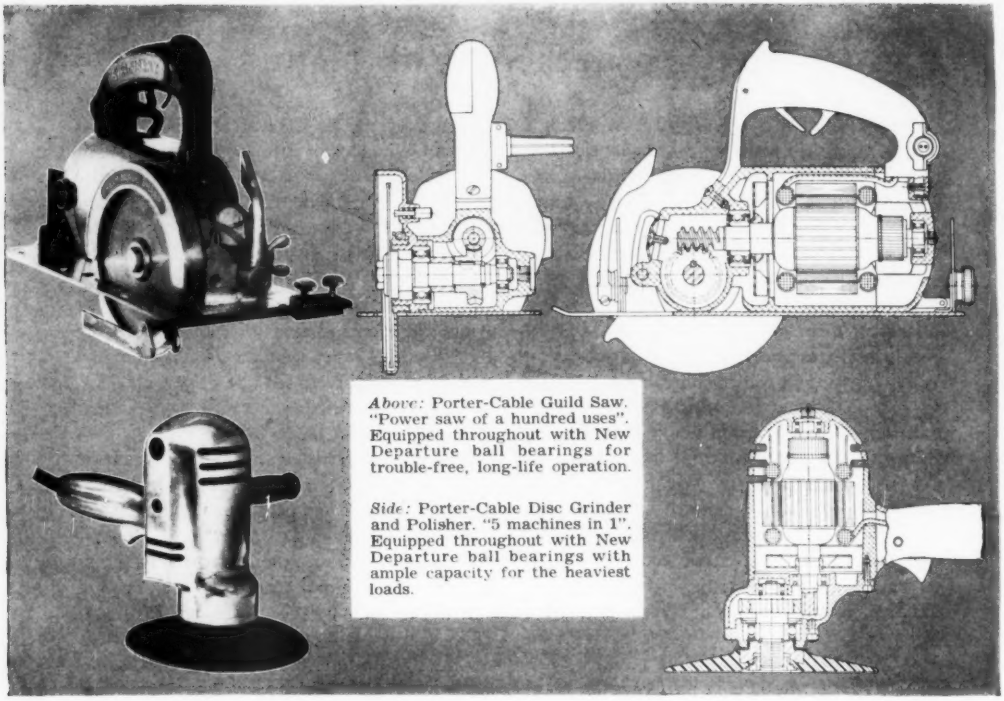
In business, the neophyte grumbles and complains that he has no opportunities and decides to go elsewhere because all the big jobs are filled. He fails to realize that probably long before he can qualify to fill one of the big jobs, most of the present holders will have retired, gone elsewhere, or died.

Because its original research objectives have been fulfilled and its products are now far ahead of those of their competitors, a company decides to save money by discontinuing its research. Competitors see their opportunity, intensify their research and soon leave the economy minded corporation far behind in product leadership. A successful designer is gleeful over his new brain child just coming off the production line and then is chagrined when he learns that the leading competitor has a similar new model. Wonderful new designs of steam locomotives had to be thrown in the waste basket when the diesel-electric suddenly replaced steam.

Admittedly, no one has the power to peer behind the curtain that veils the future. Man will always be deceived by unsuspected developments. Mistakes will always be made. Decisions will always have to be made in ignorance of what the morrow will bring because everything is always changing. That is why it does not pay to be too positive, stubborn, discouraged or over confident. And for the same reason, the engineering department that is not constantly changing the designs of its product is out of step with nature and will soon find itself outmoded—a "has been" on the pages of history.

G. F. Zodenholt

Designed with Ball Bearings . . .
for long life . . . hard usage



Above: Porter-Cable Guild Saw. "Power saw of a hundred uses". Equipped throughout with New Departure ball bearings for trouble-free, long-life operation.

Side: Porter-Cable Disc Grinder and Polisher. "5 machines in 1". Equipped throughout with New Departure ball bearings with ample capacity for the heaviest loads.

WHEN power tool specifications read — "highest quality ball bearings throughout" — that is concrete evidence that the tool builder has designed for maximum performance — for long life — for greatest owner satisfaction.

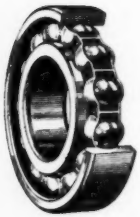
Builders of portable tools specify New Departure ball bearings because:

They hold moving parts in permanently accurate alignment.

Take all thrust and radial loads with absolute minimum of frictional loss.

Require practically no attention of any kind throughout life of tool.

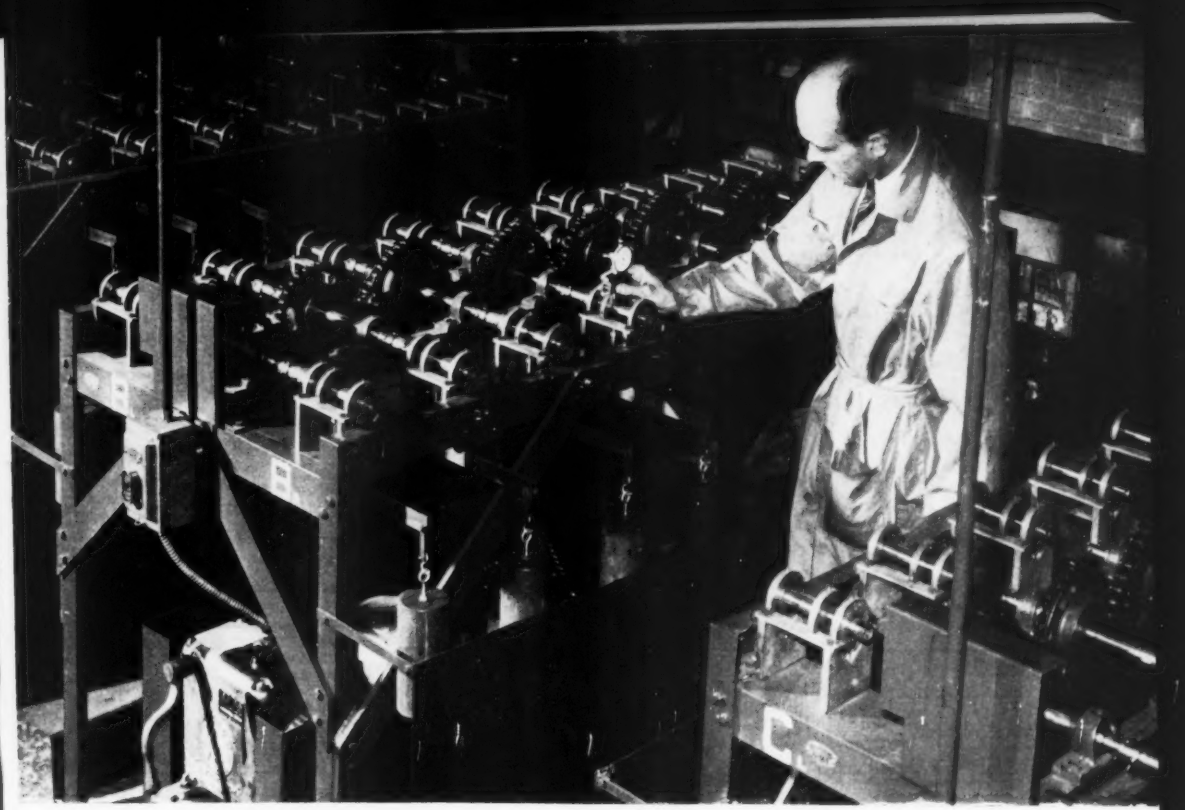
Assure delivery of maximum power at point where work is done.



Nothing Rolls Like a Ball

NEW DEPARTURE
BALL BEARINGS

NEW DEPARTURE • Division of GENERAL MOTORS CORPORATION • BRISTOL, CONNECTICUT • BRANCHES IN ALL PRINCIPAL CITIES



BATTERY OF SPECIALLY DESIGNED testing machines for determining PV values and bearing performance data.

Carbon-Graphite Parts

FREMONT F. RUHL
Graphitar Engineer
United States Graphite Company

POWDERED CARBON and graphite, mixed with a suitable petroleum base binder, compacted under high pressure and then furnaced at a temperature exceeding 3,000 deg. F, produces a hard, strong and light material that possesses many unusual properties that are highly desired for certain applications. The final product is 95 to 99.8 percent carbon, the binder having been reduced to carbon in the furnacing process. However, during processing the properties of the amorphous graphite are not measurably changed, the surface of the finished part possessing the slipperiness characteristic of that material.

It is the slipperiness of the surface which gives carbon-graphite an exceptionally low coefficient of dry friction, about 0.12, a coefficient that is lower than that of any of the metallic bearing metals. Brass on steel is 0.15. In combination with this unique property, carbon-graphite parts exhibit the characteristic properties of carbon. The material has no measurable plasticity or ductility even at elevated temperatures, and its coefficient of thermal expansion, only about 0.0000015 in. per in. per deg F in the temperature range from 75 to 625 deg F, is about one-fourth that of steel, which is 0.0000065. Hence carbon-graphite bearings or other parts undergo no appreciable change in shape or dimensions when their temperature is increased from room temperature to 600 or more deg F. In addition, the material has a relatively high heat conductivity, high heat radiating capacity (practically perfect black body radiation), relatively high strength, unusual resiliency, and high hardness. This unusual combination of properties makes carbon-graphite the first choice material for many bearing applications and parts that are subjected to rubbing contact with metal.

Because of the many variables that enter into the manufacture of carbon-graphite to its finished form, the numerical values of the properties of the material are different for different grades and makes. The purity of the base materials, the fineness of the powders, the efficiency of the mixing, the compacting pressure, the furnacing temperature and many other factors appreciably affect the properties of the final product. By proper techniques and controls, innumerable grades of carbon-graphite have been produced, each grade tailored to possess certain unusual combinations of properties.

Strengths and other properties given in Table I are those of the carbon-graphite material Graphitar, produced by the United States Graphite Company.

A general misconception is that carbon-graphite parts are highly brittle. To the contrary, balls made of Graphitar when dropped upon a smooth con-

Table I—Physical Properties of Graphitar Grades of Carbon-Graphite

Graphitar Grades	Average Shore Hardness	Average Transverse breaking strength	Average Tensile strength	Average Compressive strength	Friction 1—Low 2—Medium to low 3—Medium
1	70	8,000	600	12,000	3
2	85	10,000	1,100	20,000	2
3	75	8,000	800	14,000	3
4	55	7,000	500	11,000	3
5	70	8,000	600	12,000	2
6	85	10,000	1,100	20,000	2
7	75	8,000	800	14,000	2
10	55	7,000	500	11,000	2
14	100	13,500	2,500	35,000	1
20	45	6,000	900	10,000	3
30	80	10,000	1,200	18,000	1
31	80	10,000	1,200	18,000	1
39	100	13,500	2,500	35,000	1
40	80	12,000	1,000	24,000	3
41	90	14,000	2,500	30,000	2
42	90	12,000	1,000	24,000	2
43	80	12,000	1,000	24,000	3
45	80	12,000	1,200	24,000	2
46	60	8,000	1,000	14,000	2
47	90	15,000	2,000	31,000	2

crete slab will rebound up to 73 percent of the height from which they were dropped.

Design Precautions and Tolerances

Shape limitations in the design of powdered carbon-graphite pressing are practically the same as those that apply to powdered metal pressings. The pressure applied by the punch will be exerted only in the direction of its movement. The amount of pressure exerted in lateral directions is negligible insofar as the compacting is concerned. Thus the walls of the die may taper or be stepped inward toward the bottom of the die but there can be no undercuts in the walls of the die.

After the pressing or compacting operation the parts are furnaced at a temperature of more than 3,000 deg. F. During this process small dimensional changes take place. The amount of the dimensional changes varies slightly for the different grades of Graphitar. Tolerances of the furnaced parts, called molded tolerances, are as follows:

Molded Tolerances of Graphitar Parts

OD and ID and cross-sectional dimensions—1½ percent of nominal or 0.010 in., whichever is greater

Length—10 percent of nominal dimension or 0.040 in., whichever is greater

If the above tolerances are acceptable, no further operations are required on the part. However, much closer dimensional accuracy can be obtained by grinding and lapping operations. In the following table are given the dimensional tolerances obtained by added operations or greater precision. Naturally the cost of the part increases somewhat as closer limits are specified. Hence the designer should specify the largest tolerances that will be permissible.

Tolerances for Ground Diameters

Successive Operations	Diameter Tolerance
Clean-up grind	0.015 in.
Rough ground	0.004 in.
Smooth ground	0.002 in.
Finish ground	0.001 in.
Precision ground	0.0005 in.
Precision ground	0.0003 in. only up to ½ in. dia

Surface Flatness Tolerances

Operation	Tolerance
Molded	10 percent of nominal dimension
Rough ground	±0.010 in.
Smooth ground	±0.005 in.
Finish ground	±0.0005 in.
Commercial lap	±0.0001 in.
Finish lap	6 light bands
	3 light bands

Although carbon-graphite parts can be machined, the high-speed steel cutting tools will lose their edges quickly. Tungsten carbide and diamond cutting tools are often used. Drilling is done with two fluted drills. The edges of drilled holes will invariably chip slightly on account of the nature of the material. Hence wherever possible the edges of the holes should be chamfered although in most parts the chipped edges do no harm as they are not of the nature of a burr.

Following are some precautions to be observed with reference to the shape of carbon-graphite parts:

1. Flat pieces should not be less than ¼ in. thick.
2. Cylinder walls should not be less than 3/16 in. thick.
3. Do not put slots or keyways in the inside wall of tubular parts or rings. Put them in the outside wall.
4. Do not design bearings with high flanges, but use two pieces instead, a bushing and an end plate.
5. Keep cross-sections simple.
6. Do not press-fit sleeves over shafts.
7. Do not press fit seals into a metal retainer.

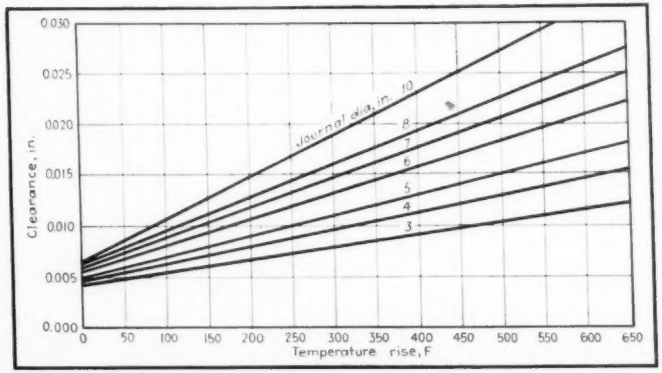


Fig. 1—Clearances for journals of various diameters running in non-lubricated carbon-graphite bearings at given temperature rises, as determined by many laboratory tests.

Carbon Graphite Bearings

The most extensive use of carbon-graphite parts is for bearings and related parts. Such bearings can be run

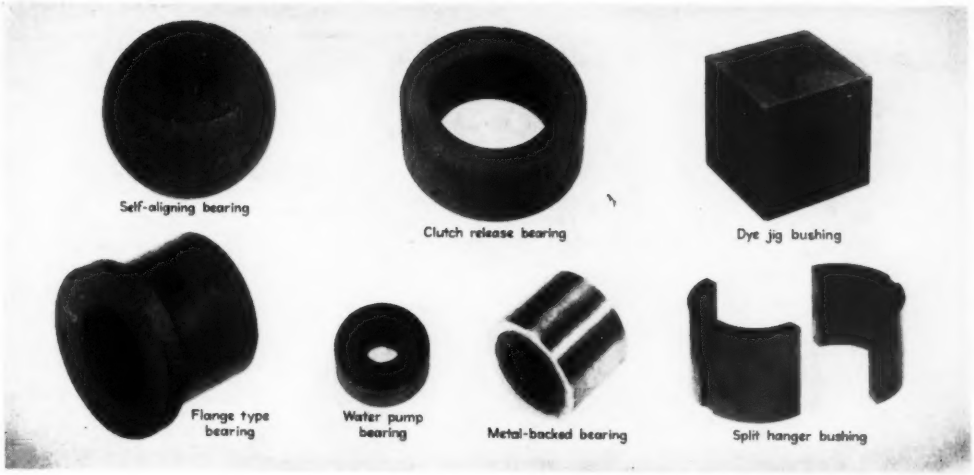


Fig. 2—A few of the many types of carbon-graphite bearings available.

with a coefficient of friction ranging from 0.04 to 0.25, depending on the grade of Graphitar and the manner of its application. Carbon-graphite bearings can operate in air at temperatures up to 700 deg F with little or no oxidation. At higher temperatures, up to the maximum temperature that the journal can withstand, the carbon-graphite will not melt, oxidize or deteriorate otherwise if it is shut off from air or surrounded by a non-oxidizing or reducing atmosphere.

The small coefficient of thermal expansion, only 0.0000015 in. per in. in the temperature range of 75 to 625 deg F, about one-quarter that of steel, is sometimes an advantage in bearing applications. In addition, its high heat conductivity and high heat radiating capacity, which approaches true black body radiation, combine to give such bearings a high heat dissipating capacity.

Because carbon-graphite bearings can be run dry they are used extensively in textile machinery and equipment where a lubricant might damage the goods being processed. The bearings are used extensively in chemical equipment where a metal bearing would be attacked by the chemicals. In many places where the bearings are inaccessible or difficult to lubricate, carbon-graphite bearings are used and run dry. These bearings are also applied where they will be subjected to high temperatures as in furnace parts.

Bearing Design

With the bearing load, journal diameter and speed known, the allowable unit bearing pressure can be obtained from Fig. 3 or Fig. 4 and the projected area can then be calculated. From these figures the length of the bearing can be computed. The curves in Figs. 3 and 4 are based on pv values of 150,000 for lubricated bearings and 15,000 for bearings to be run dry. If the bearing is operated at somewhat higher pv values, a somewhat higher rate of bearing wear will result.

In passing it should be mentioned that here have been a few highly unusual applications in which Graphitar bearings have operated intermittently at a pv value of 1,000,000, with good results. Such performances are admittedly rare and can only be explained by exceptional mating material and superlative finishes of the bearing and mating surfaces. However, these exceptional performances do indicate not only the importance of finishes but also the performance pos-

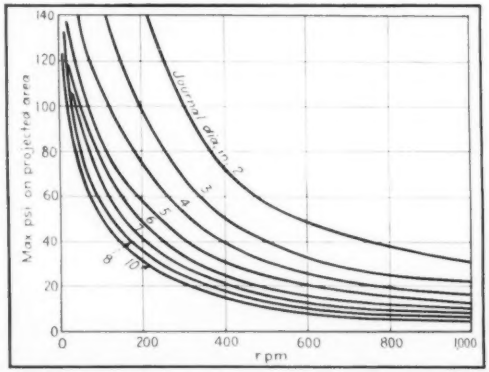


Fig. 3—Allowable unit bearing pressures on non-lubricated carbon-graphite bearings of various journal diameters and speeds.

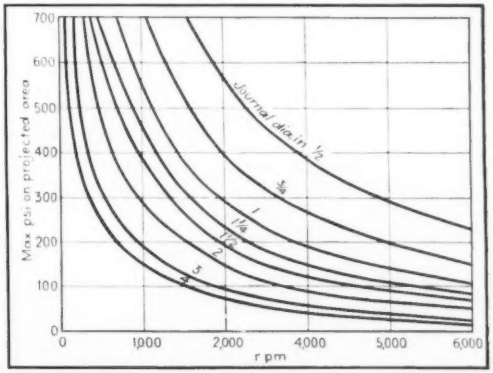


Fig. 4—Allowable unit bearing pressures on lubricated carbon-graphite bearings of various journal diameters and speeds.

Fig. 5—Parts made of carbon-graphite because of its dimensional stability, heat and corrosion resistance, and low friction.

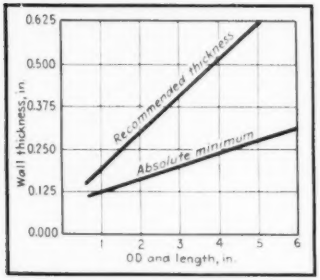


Fig. 6—The wall thickness of the bearing is readily obtained from this chart.

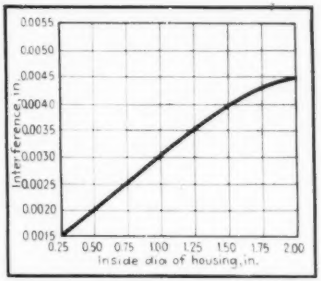


Fig. 7—Interference fit required for press fitting bearing in the housing.

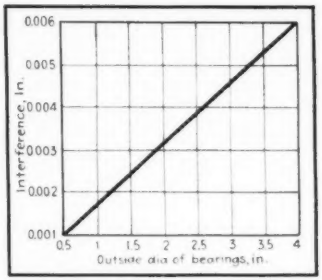


Fig. 8—Interference on OD required for shrink fitting bearing in the housing.

sibilities of Graphitar bearings.

With the length and inside diameter of the bearing established, Fig. 6 can be used to determine the minimum wall thickness for a solid bearing. The bearing may be either press fitted or shrink fitted into its housing. Figs. 7 and 8 give the interference for different diameters for press fits and shrink fits respectively. The inside diameter of the bearing will be closed-in slightly by the pressure of the fit, either press or shrink. The amount can be determined by referring to Fig. 9. The net diameter less the average running clearance as obtained from Fig. 10 will be the nominal diameter of the journal. With these figures established the designer can work backwards from a specified exact journal diameter to find the ID and OD of the bearing. In establishing tolerances, because it is more economical to hold closer tolerances on a journal, rather than the ID of the bearing, the greater dimensional variation should be allowed on the ID of the bearing.

Average running clearances are considerably larger for carbon-graphite bearings than for metal bearings. Carbon-graphite is not ductile and does not flow plastically, and the bearings have no appreciable "run-in" wear as do metal bearings. The initial clearance in a carbon-graphite bearing does not increase appreciably during the life of such a bearing and is not much greater than that in most metal bearings after they have been run for a time.

On the other hand, a higher initial clearance is necessary in a carbon-graphite bearing so that it can accommodate slight shaft misalignments and shaft deflections. The bearing cannot "bell mouth" as do metal bearings to accommodate shaft deflections and misalignment. In line with this, carbon-graphite bearings should be designed as short as practicable if shaft misalignment is expected to be serious

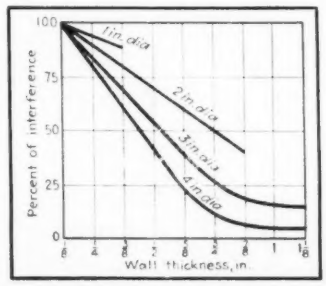


Fig. 9—Amount of close-in of bearing bore can be calculated from this chart.

For large misalignments, self aligning Graphitar bearings should be used.

Kerosene, water or alcohol can be used for lubricating carbon-graphite bearings. Because of the finely controlled porosity of the porous grades of Graphitar bearings, these fluids will maintain a liquid film under relatively high loads. Oil could be used for the lubricant but the coefficient of friction would be higher than that obtained when using water, alcohol or kerosene. Lubricant impregnated carbon-graphite bearings are also available. Whether the bearing be run dry or lubricated, it will develop a mirrorlike polished surface and the journal will be burnished to a similar polish. Such surfaces will run with an extremely small rate of wear.

Other Applications of Carbon-Graphite Parts

Because of its low coefficient of friction, dimensional stability, high wear resistance and resistance to heat and chemicals, carbon-graphite is used extensively for seals, turbine packing rings, packing box seal rings, lantern rings and as cylinder liners. Carbon-graphite is used for rotary pressure joint seals for handling steam, water, hot oil, powdered talc and many chemicals. In rotary pressure joints the Graphitar seal ring mates with a spherical surface of cast iron, (preferred), bronze or stainless steel. All the surfaces are ground smooth. Seals on fluid couplings, torque converters and hydraulic transmissions are also made of carbon-graphite.

Non-lubricated compressors handling steam, air, oxygen and chemically pure gases are made with carbon-graphite piston rings and rider rings. The piston rings are made in three segments and forced against the cylinder wall by an inner expander spring. In such applications the use of a lubricant would contaminate the materials handled.

Another pump application is Graphitar cylinder liners and Graphitar pistons for gasoline fuel pumps and refrigerator compressors. The liner is shrink-fitted in the pump body and then diamond bored to the required diameter.

Other applications include vanes on rotary pumps, centrifugal pump wearing rings, molds for the glass industry, pump valves, metering disks.

Summarizing, Graphitar parts are the preferred or only material that can be used successfully in applications where rubbing surfaces cannot be lubricated because of inaccessibility, damage to material handled, or other reasons; where the part will be subjected to high temperatures; where the part will be subjected to corrosive chemicals or media; where high dimensional stability is required; and where high wear resistance is needed.

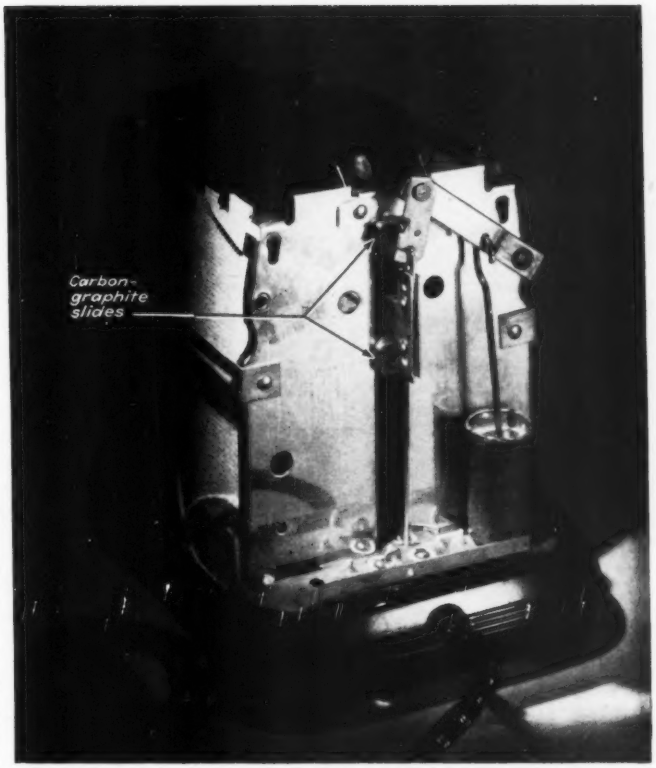


Fig. 12—Carbon-graphite pressings are used for the slides on this automatic electric toaster because of its heat resistance, dimensional stability and low friction.

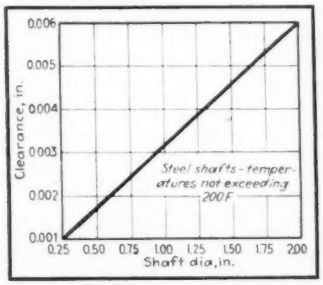


Fig. 10—Journal clearance for small shafts running without lubricant.

Fig. 11—The flat surface of thrust bearings can be finish lapped to a smoothness of only three light bands showing under an optical flat.

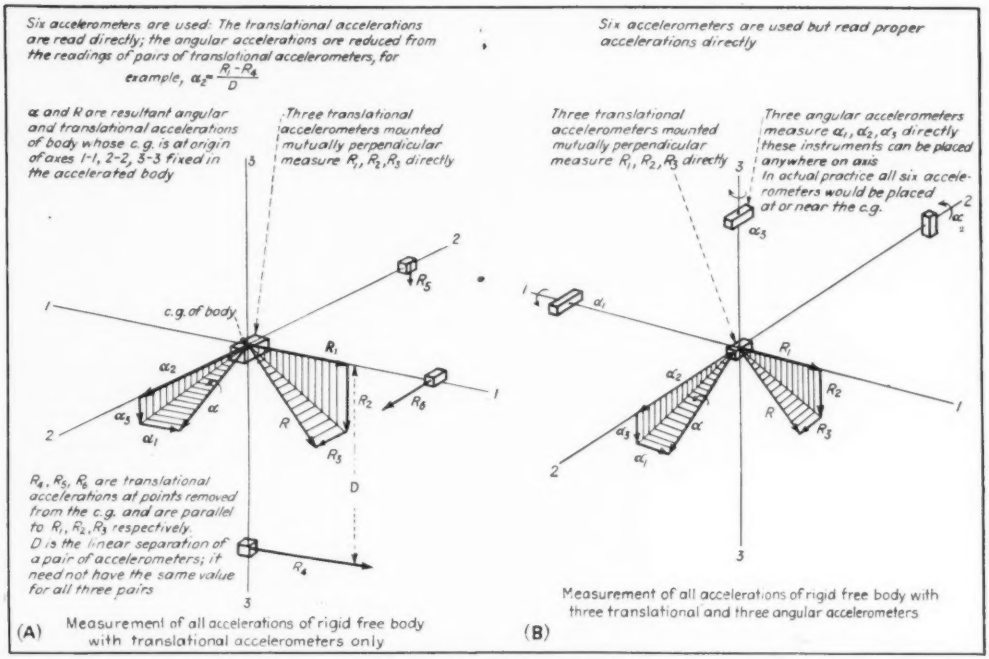

Six accelerometers are used: The translational accelerations are read directly; the angular accelerations are reduced from the readings of pairs of translational accelerometers, for example, $\alpha_2 = \frac{R_1 - R_4}{D}$
α and R are resultant angular and translational accelerations of body whose c.g. is at origin of axes 1-1, 2-2, 3-3 fixed in the accelerated body
Three translational accelerometers mounted mutually perpendicular measure R_1, R_2, R_3 directly
c.g. of body
R_4, R_5, R_6 are translational accelerations at points removed from the c.g. and are parallel to R_1, R_2, R_3 respectively.
D is the linear separation of a pair of accelerometers; it need not have the same value for all three pairs
(A) Measurement of all accelerations of rigid free body with translational accelerometers only
Six accelerometers are used but read proper accelerations directly
Three translational accelerometers mounted mutually perpendicular measure R_1, R_2, R_3 directly
Three angular accelerometers measure $\alpha_1, \alpha_2, \alpha_3$ directly these instruments can be placed anywhere on axis
In actual practice all six accelerometers would be placed at or near the c.g.
(B) Measurement of all accelerations of rigid free body with three translational and three angular accelerometers

Fig. 1—Instrument setups for measuring accelerations of a free rigid body about three mutually perpendicular axes. (A) Setup in which only translational accelerometers are used. (B) Setup in which both translational and angular accelerometers are used.

Instrument for Measurement Of Angular Accelerations

An electro-mechanical transducer designed to produce electrical changes in a circuit that are proportional to the angular accelerations applied to a structure. Construction of an angular accelerometer and the theory underlying its operation are described.

D. E. WEISS*

Head, Structural Equipment Division, Naval Air Experimental Station

IN PROJECTS having for their objectives the improvement of the properties or performance of an existing structure, it is often essential to analyze the transient forces and torques acting upon it or its component parts. Such an analysis is especially desirable when the stresses set up in the structure, or a part of it, are related to changes in the direction and magnitude of its motion.

In making the analysis, the engineer needs to know how the material in the part or structure is distributed about some reference point and also the translational and angular acceleration of the part or structure. With drawings available, the distribution of material can be readily ascertained. For accurate information concerning accelerations at any particular time interval, the engineer must rely on data supplied by test instruments.

In the design and construction of one group of test instruments, the accelerometers, a sensitive spring-mass system is usually employed in such a way that the relative motion of the mass element with respect to the accelerated body is proportional to the applied acceleration. This motion is very small and is detected and amplified by electrical means.

Translational accelerometers capable of measuring only linear acceleration over short or long time periods have been in use for some time. When placed at the center of gravity of a moving body, these instruments record only translational accelerations. When these instruments are placed at a distance from the center of gravity of the body, they respond to the sum of the translational acceleration of the center of gravity and the tangential acceleration caused by angular acceleration at the place of attachment.

Unless pairs of translational accelerometers are used and are carefully lo-

* *The opinions or assertions contained herein are the author's, and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.*

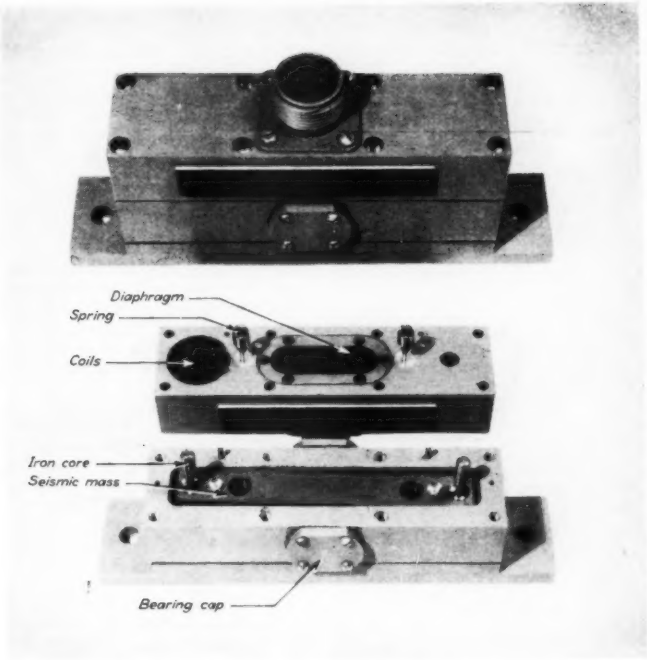


Fig. 2—Recently developed N.A.E.S. angular accelerometer, with cover attached and removed. Natural frequency can be changed by inserting springs with different rates.

cated with respect to the center of gravity, it is not possible to interpret fully the readings obtained. Although six translational accelerometers may be arranged so that their readings can be used to compute all accelerations on a free rigid body, for many motion studies it is more convenient to use three translational and three angular accelerometers, the latter reading directly in radians per sec per sec. In Fig. 1 (*A*) is shown how all accelerations of a body are measured when only translational accelerometers are used. Fig. 1 (*B*) shows the arrangement when angular accelerometers are used with translational accelerometers.

The superiority of the second method, Fig. 1 (*B*), becomes apparent when it is observed that the calculation of angular acceleration from pairs of translational accelerometers requires taking the difference of two readings. In many applications the inherent error of a translational accelerometer, while small in itself, may be large compared to this difference and hence introduce large percentage errors in the calculation of the angular acceleration.

Further in Fig. 1(*A*), it is assumed that the sensitive axes of each pair of translational units are exactly parallel and hence equally insensitive to translational centrifugal accelerations directed perpendicularly to each axis. Small deviations from a parallel condition can lead to large errors in the calculations.

Since angular accelerometers are a recent development, the theory of application and the principles of construction of one such instrument on which a patent is pending, Fig. 2, will be described here.

Angular Accelerometer

In the instrument shown in Fig. 2, a balanced mass is torsionally suspended within a rigid case. A rectangular brass beam, 4 x $\frac{1}{2}$ x $\frac{3}{4}$ in., together with two helical springs in tension comprise a spring-mass system constrained to one degree of freedom, that is, rotation about an axis passing through the center of gravity of the beam and perpendicular to its length.

The constraint is accomplished by a double conical pivot that is rigidly attached to the beam and supported by two sets of ball bearings symmetrically disposed in the case. The beam is precisely balanced to avoid response to linear accelerations.

The helical springs can quickly and easily be replaced by others of different stiffness to change the natural frequency of the instrument.

To damp the spring-mass system, the instrument is filled with organosilicones; thermal expansion or contraction of the fluid is accommodated by an elastic diaphragm in cover.

Near each end of the beam is attached an iron core; two cores are used to obtain mechanical balance. One core floats as an armature in a set of coils contained in the cover. The coils consist of three adjacent coaxial windings of No. 36 wire.

An alternating voltage of 2 to 10 volts at 2,000 cps is impressed on the center coil. The voltage induced across the outer coils varies with the position of the iron core in the coils. Thus the relative motion of the beam with respect to the case is indicated by a change of voltage across the outer coils. The outer coils are connected in series to form two arms of a bridge circuit as shown in Fig. 3. The other two arms are germanium diodes. Initial balance of the bridge is achieved by a 100 ohm potentiometer in series with the diodes. The electrical output of the system actuates a moving coil galvanometer without the need for amplifiers.

In operation, the bridge is initially balanced by adjustment of the potentiometer. Beam movement, as a result of angular acceleration, changes the position of the iron core in the set of coils. As a result of this motion, the induced voltage increases across one of the outer coils and decreases across the other outer coil, thus causing current to flow through the galvanometer.

The half wave rectification produced by the double diode is smoothed out by the galvanometer, which has a relatively low natural frequency of 40 to 160 cps. The double diode also provides phase discrimination, so that a reversal of beam motion causes reversal of the direction of galvanometer current. The shunt across the galvanometer must be adjusted to provide damping of the galvanometer.

An accurate and reproducible mag-

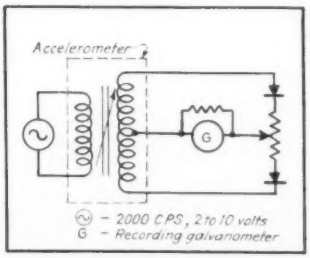


Fig. 3—Basic electrical circuit for angular accelerometer and recording galvanometer.

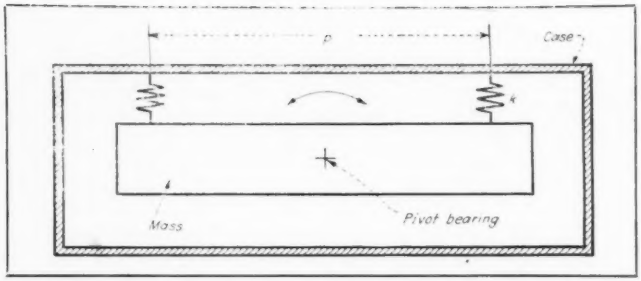


Fig. 4—Elements in the spring-mass torsional system of angular accelerometer.

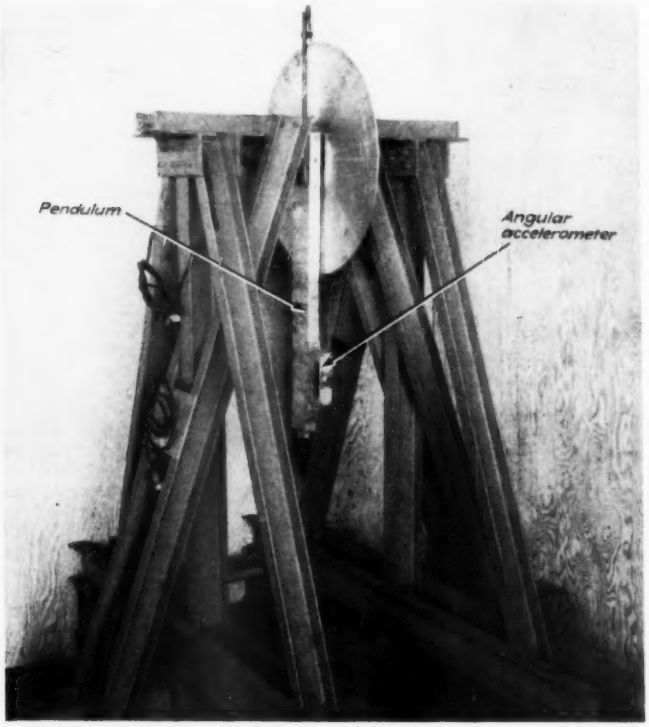


Fig. 5—Pendulum for calibrating static sensitivity of an angular accelerometer.

nification of approximately 1,000 is obtainable with this circuit using commercially available galvanometers. Further, the galvanometer deflection is directly proportional to the armature motion over a wide range.

The accelerometer described has also been used with a more complicated, but commercially available, multi-channel a-c bridge amplifier system, which is widely used with variable resistance-wire strain gages for recording dynamic strains. But the extra instrumentation is needed only if a higher frequency response or greater sensitivity is required.

Theory of Angular Accelerometer

Where C is the torsional stiffness constant and I the moment of inertia of the spring mass system, the natural frequency of a torsion pendulum is

$$f_n = \frac{1}{2\pi}\sqrt{\frac{C}{I}} \qquad (1)$$

or

$$I = C/4\pi^2 f_n^2 \qquad (2)$$

An angular acceleration α applied to the instrument case will cause a torque Q to act on the beam such that

$$Q = \alpha I = \alpha C/4\pi^2 f_n^2 \qquad (3)$$

Where θ is the relative angular displacement of the beam with respect to the case, a torque applied statically within the proportional limit of the springs, can be expressed as

$$Q = C\theta \qquad (4)$$

then combining Eqs (3) and (4)

$$\theta = \alpha/4\pi^2 f_n^2 \qquad (5)$$

The angular displacement of the beam relative to the instrument case is therefore directly proportional to the angular acceleration applied to the case and inversely proportional to the square of the natural frequency of the suspension.

While the foregoing equations have been developed for a statically applied torque, it can be shown by analogy to the theory of the linear accelerometer, (see "Design and Application of Accelerometers," D. E. Weiss, *Proceedings* of the Society for Experimental Stress Analysis, Vol. IV, No. 2), that Eq (5) holds true as long as the applied torque frequency is small compared to the natural frequency of the instrument. By the use of 65 percent of critical damping, obtained with organo-silicones of the proper viscosity, the range over which the frequency response is flat can be extended to approximately 80 percent of the natural frequency of the instrument.

The natural frequency of the NAES instrument can be computed easily in terms of the moment of inertia I of the beam, the linear spring stiffness k, and the spring separation p, Fig. 4. Equating the maximum kinetic and potential energies for an undamped free vibration of amplitude θ, thus

$$\frac{I}{2}(\omega_n\theta)^2 = 2\left[\frac{k}{2}\left(\frac{p\theta}{2}\right)^2\right] \qquad (6)$$

and substituting

$2\pi f_n$ for ω_n,

there results

$$f_n = \frac{p}{2\pi}\sqrt{\frac{k}{2I}} \qquad (7)$$

For this type of torsional suspension, Eq (7) is the basis of design.

Since Eq (5) is true only under certain frequency conditions, calibrating accelerations at different frequencies must be applied to the instrument.

A complete calibration consists of two determinations, namely, the static and the dynamic sensitivities.

In determining the static sensitivity, the instrument output is measured, by means of the circuit of Fig. 3, as a

function of the magnitude of the acceleration at zero frequency or some frequency less than 0.2 of the natural frequency of the instrument. The technique includes the use of a pendulum calibrator, Fig. 5, that applies the acceleration at a frequency of 0.5 cps, or one sufficiently low as not to produce results that will differ measurably from a static calibration.

In determining the dynamic sensitivity, the instrument output per unit of acceleration is measured as a function of the frequency of the applied acceleration. The dynamic calibration, Fig. 6, is carried out by subjecting the instrument to sinusoidal angular accelerations of known peak values.

Uses for Angular Accelerometers

Plots of acceleration-time histories and other test data obtained with accelerometers are valuable as an aid to the improvement of product designs in many fields of engineering. Such test data can be used: To check the pitching and rolling moments in cars and their effect on riding comfort; to improve the structure and the performance of small boats; to improve the performance of heavy machinery in which large transient inertia forces are present; to prove and improve the structural adequacy of aircraft; to improve the stability characteristics of guided missiles; to evaluate the design of large shipping containers; to check the effectiveness of shock absorbers; and to determine the forces and moments to which railroad and truck shipments are subjected.

The correlation of accelerations with other data such as velocity, strains at critical points, and pressures can be made by an oscillograph in which several moving coil galvanometers are inclosed.

The oscillogram shown in Fig. 7 was obtained in an investigation of a scout seaplane during landing. Instruments used were: Three linear accelerometers mounted mutually perpendicular at the center of gravity of the plane, one angular accelerometer to measure pitching acceleration, and seven sets of strain gages mounted on the struts through which the loads are transmitted from the float to the fuselage. By applying known loads in the laboratory, the structural strains were calibrated in terms of the applied forces and moments. Thus it was possible to check the reading of the angular accelerometer against the pitching moment as measured by the strain gages.

For clarity only three traces are identified on the oscillogram: (1) The output of the angular accelerometer; (2) and (3) the outputs of the two sets of gages responsive to pitching moments. The peak pitching acceleration obtained from the response of the two sets of gages was 9.16 radians per sec per sec; the same quantity measured by the angular accelerometer was 9.24 radians per sec per sec. In general, whenever the transient acceleration was of relatively long duration, as during the impact recorded, agreement within 10 percent was obtained between the accelerometer and strain gage determinations of the pitching accelerations. Poor agreement was obtained when the accelerations were vibratory and of short period. This result is to be expected because the natural frequency of the angular accelerometer was 17.3 cps, damped to 70 percent of critical. All frequencies above approx 9 cps, therefore, are attenuated by the instrument.

Also the angular accelerometer lags the response of the strain gages. This result, too, is to be expected since the response of the strain gages is almost instantaneous, while that of the accelerometer lags appreciably because of the relatively low natural frequency of its sensitive element. Doubling the natural frequency of the accelerometer would halve the delay time, but would increase the response to local vibratory accelerations from the engine approximately four-fold. Further, the sensitivity would be reduced by a factor of four.

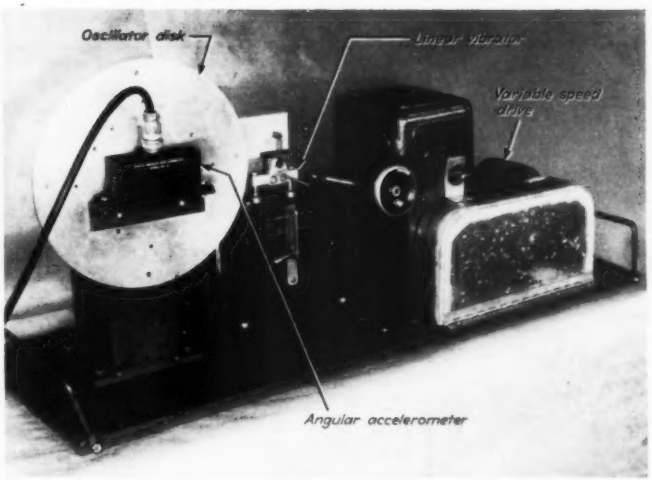


Fig. 6—An arrangement for calibrating dynamic sensitivity of an angular accelerometer.

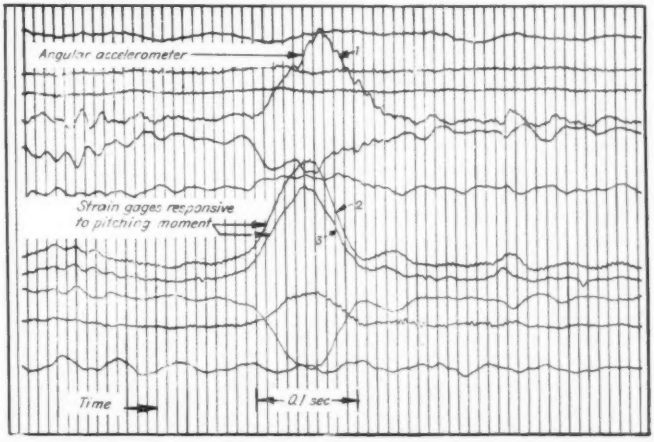
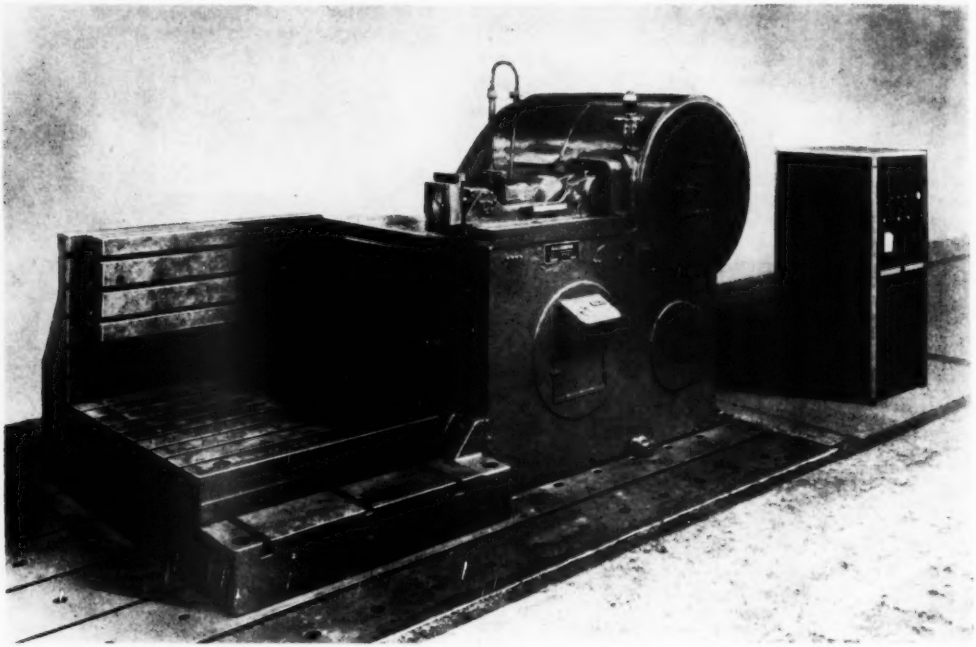


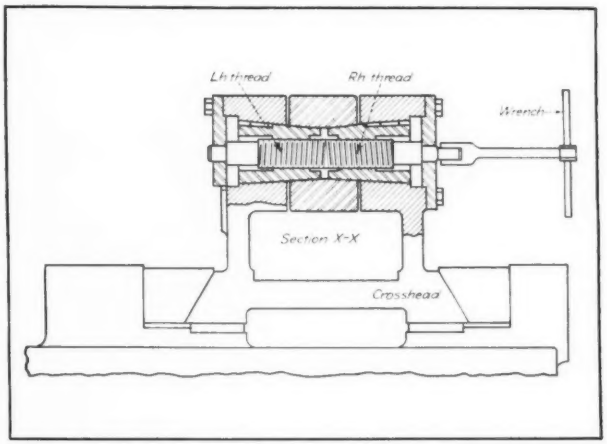
Fig. 7—Pitching moments and accelerations recorded during landing of a Navy seaplane.



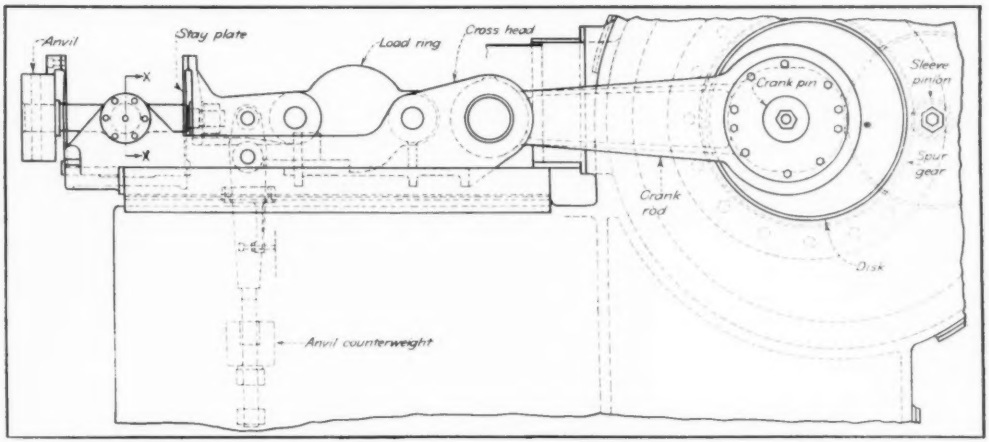
FATIGUE TESTS of parts or assemblies up to 5 x 5 x 5 ft can be made on this machine. Separate cabinet contains automatic equipment for controlling and indicating load. Chart recorder in cabinet shows test results graphically.

Stroke of Fatigue Tester Is Varied Automatically

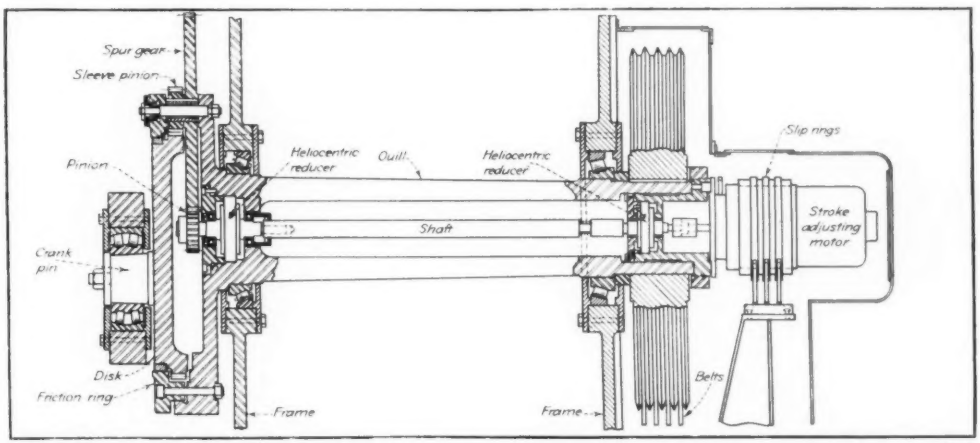
Elongation of parts under fatigue test is automatically compensated for in a constant force fatigue testing machine built by the Baldwin Locomotive Works, Philadelphia. Length of stroke may be varied between 0 and 8 in. The machine which can exert a force of 10,000 lb was developed to meet the need for testing equipment capable of loading full-sized parts or assemblies under simulated service conditions. Maximum speed of this tester is 250 cycles per minute.



IF IT IS DESIRED to run a test under conditions of constant stroke length, the load ring may be by-passed as shown in this view. By rotating the handle counterclockwise the clearance around the loosely fitting tapered plugs is taken up forcing them tightly upon their seats. Thus there is established a fixed and rigid connection from the anvil to the crosshead, by-passing the ring which is no longer subjected to load and hence no longer deflected.



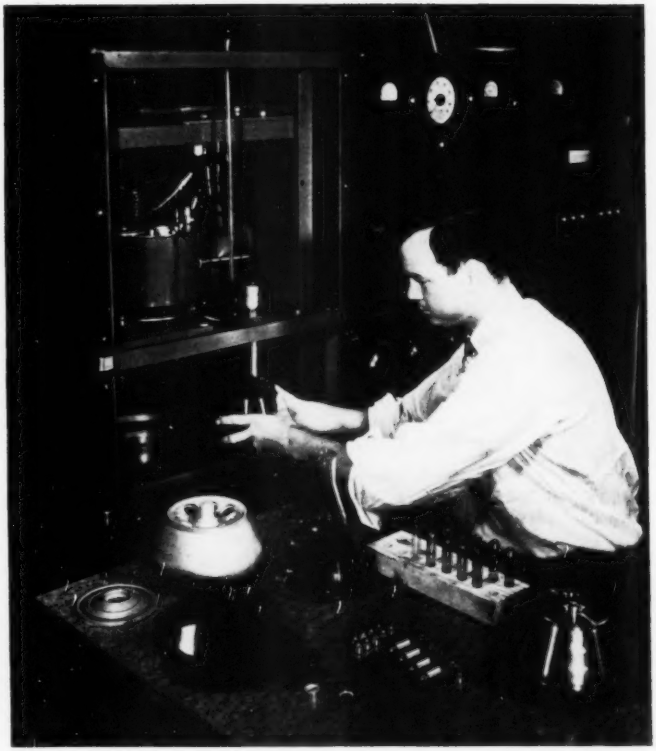
HEART OF MACHINE is a dynamometer ring which transmits load from reciprocating crosshead to the specimen. Left hand eye of the ring is connected to the anvil and the right hand eye is pinned to the crosshead which slides in the frame on bronze guides. Deflection of dynamometer ring causes corresponding changes in the air gap of a transformer mounted directly on it. Voltage of this transformer is therefore always proportional to load transmitted through ring. Transformer is connected across a galvanometer which reflects a light spot that swings back and forth across a graduated scale in proportion to voltage and hence in proportion to load transmitted through ring. A photo cell is positioned so that the light spot will strike it at the end point of a swing corresponding to the selected fatigue load. When specimen weakens, load decreases, reducing dynamometer ring deflection and transformer voltage. This causes light spot to fall short of photo cell, de-energizing normally closed time delay relay. Relay closes circuit to stroke adjusting motor which changes the eccentricity or throw of the connecting rod that drives the crosshead. Adjusting screw on crosshead trips limit switch and stops machine when stroke reaches preset length.



FOUR V-BELTS transmit power from the driving motor which is in the lower portion of the housing to the flywheel pulley. This pulley is mounted on a crank quill running on roller bearings. The outer end of the quill supports a disk having an eccentric crank pin. A friction ring holds the disk in place but permits it to be rotated in relation to the quill when desired. Through a series of gears, the disk is connected to a shaft running back through the center of the quill to the stroke adjusting motor which is secured to and rotates with the quill. Power for the stroke setting motor is transmitted through three slip rings. A solenoid operated brake prevents the load on the crank pin from causing motor to creep. At zero stroke, crank pin axis is concentric with axis of quill.

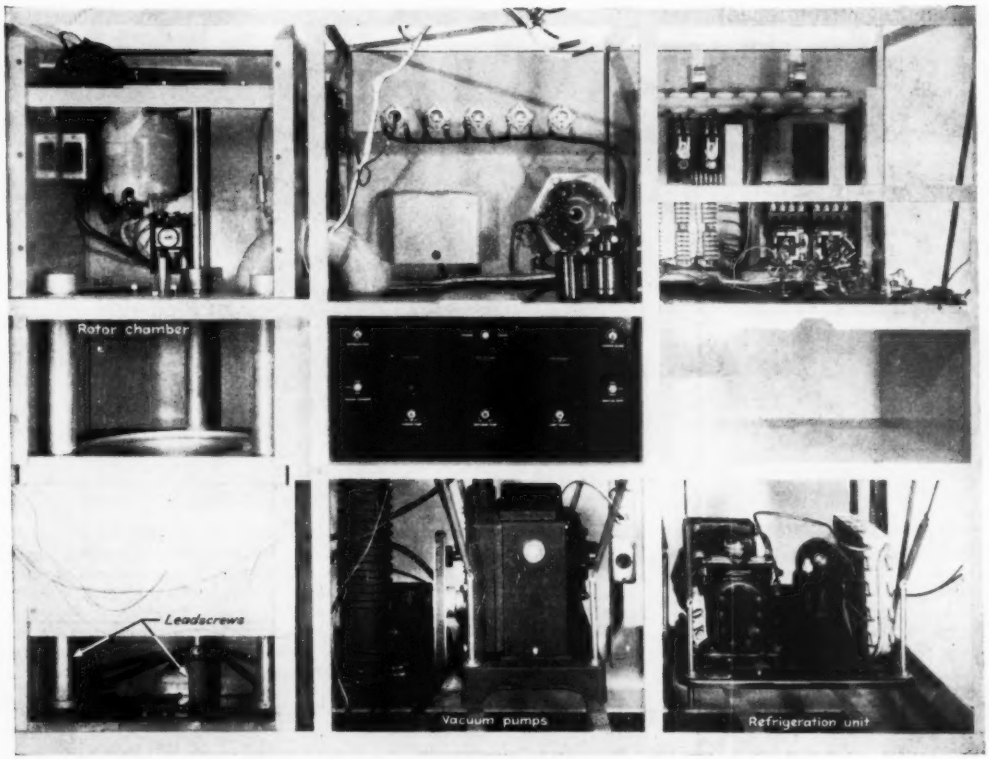
Centrifuge For Speeds To 70,000 RPM

Capable of exerting forces of 260,000 times gravity, this centrifuge is manufactured by Specialized Instruments Corp., Belmont, Calif. The apparatus was designed by Dr. E. G. Pickels as a research tool for the centrifugal purification and molecular weight determination of particles ranging from one micron down to a few thousandths of a micron in size.

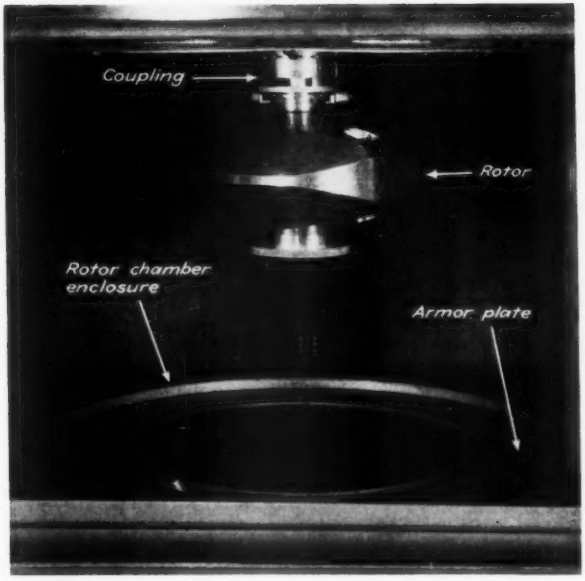


ALL COMPONENTS of centrifuge are contained in one enclosure. Black rotors shown are used to improve heat radiation to refrigerated liner of test chamber. Interlocks prevent opening of enclosure panels during operation.

PREPARATIVE ROTOR (left) is hermetically sealed when in operation by aluminum cap and rubber gasket. Expanding rubber plugs seal celluloid test cells. Knurled rod, internally threaded at one end, is used for extracting capped tubes from rotor. Analytical rotor (right) carries one test cell and a dummy for counterbalancing. Test cell is composed of centerpiece with a rectangular slot for the fluid under investigation and two end caps which hold quartz windows. In operation a high intensity light beam is projected through the sample and observations or photographs made of the movements of boundaries formed by the sedimenting particles.

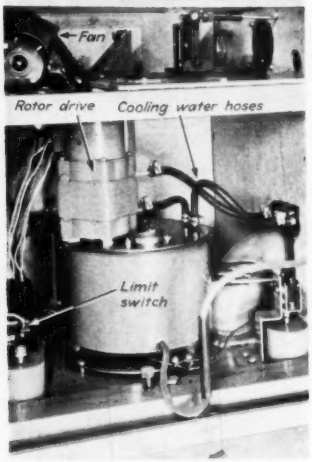


ROTOR OPERATES in a high vacuum to minimize effects of friction and turbulence. Lower portion of picture shows vacuum pump and refrigeration unit which are mounted on soft springs for vibration isolation. Rotor chamber is refrigerated for materials unstable at room temperature.

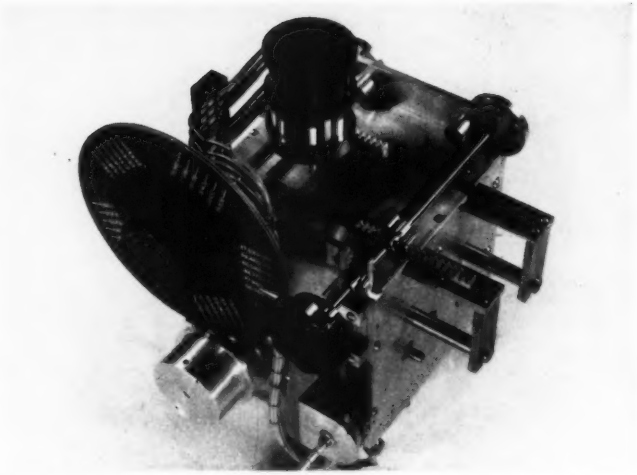


ANALYTICAL ROTOR is supported by coupling device and drive shaft of 0.1 in. diameter piano wire leading to 1½ hp electric motor. In the event of shaft failure, rotor is retained by flange of coupler and stationary fork below this flange. Rotor chamber is inclosed by housing consisting of 1/16 in. brass cylinder, a wrapping of copper tubing acting as refrigerant evaporator, a 2 in. armorplate cylinder which protects against rotor explosion and a ½ in. steel vacuum cylinder. The armor cylinder is free to turn on its axis to absorb rotational inertia in case of rotor failure. Entire housing may be lowered to position shown for access to rotor. (*continued on next page*)

Centrifuge (continued)



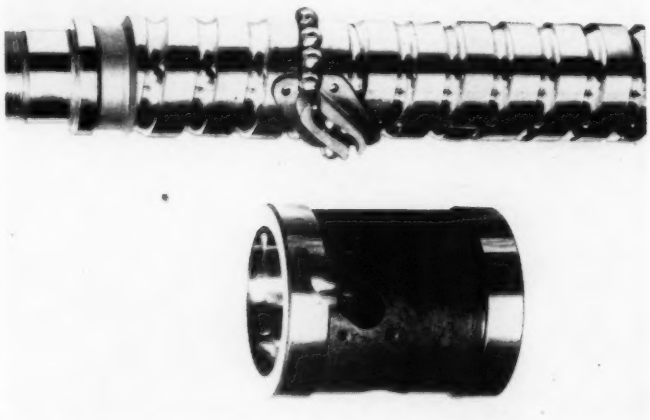
DRIVE COMPARTMENT contains 1½ hp water cooled main drive motor mounted atop gear housing. Upper ends of lead screws used for operating inclosure of rotor chamber are visible in photo. Spring mounted lower bearings allow some vertical movement of lead screws. Limit switches are actuated by reaction of screws to seating or unseating of inclosure.



ROTOR SPEED is selected and maintained automatically by means of a gearbox containing a differential transmission. One leg of the differential transmission is driven by a synchronous reference motor. The drive feeds into the second leg of the differential transmission. When the driving speed is equal to the speed delivered by the synchronous motor, the third element of the transmission remains stationary. Any change in driving speed causes rotation of the third element, movement of which actuates switches to vary voltage on drive motor and thus adjust its speed. Synchronous motor and drive transmit their rotation to the differential transmission through "five position" change gears. Thus, twenty-five speed settings are possible.

Recirculating Ball Nut

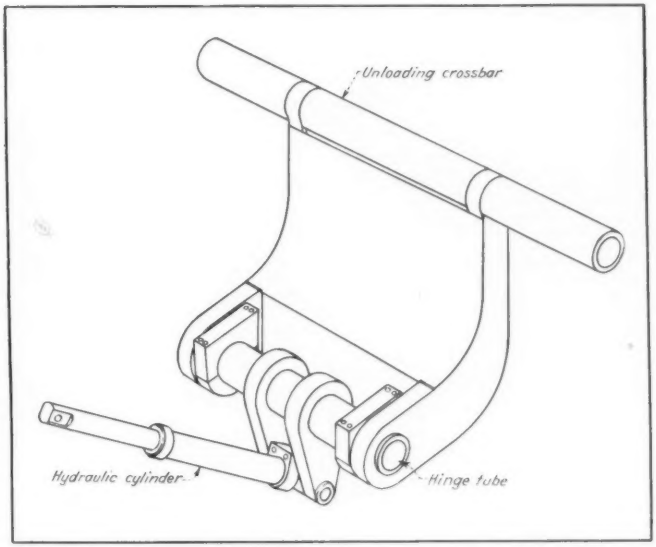
Outstanding feature of this ball nut developed by A. P. Mill Cochrane, London, England, is the method of recirculating the balls. A transfer element is used to carry the balls across the screw crest between adjacent tracks. In previous versions of the ball nut, balls filled the entire thread and were recirculated by means of a tube running outside the nut from one end of the thread to the other. The new recirculating nut has been used successfully in an efficient, fully reversible steering gear for heavy vehicles.



SCREW AND NUT are of case hardened steel. Transfer elements which are die cast zinc alloy are riveted to the nut in which clearance is provided by a milled slot. As nut rotates, transfer element scoops balls from one end of the ball string and returns them to the other. Two separate ball circuits per nut are ordinarily used.

Hydraulic Lumber Unloader

A variable relief valve controls operation of the hydraulic lumber unloader invented by Paul Penberthy, Los Angeles. Designed to save labor and reduce lumber damage, the system uses a motor driven pump powered from the truck's electrical system to build up initial pressure. The device is not meant to load lumber.



TWIN UNLOADING ARMS are braced by formed steel plate welded between them. A 25 ton capacity hydraulic cylinder is pivoted on the ends of the short cranks. Upper end of piston connects with straddle mounted blocks on a cross member of the truck frame.

LUMBER IS MOVED BACK on rollers until center of gravity is just forward of unloader crossbar. At this point, entire weight of lumber is supported by 7,000 psi pressure in hydraulic cylinder. Slight opening of control valve permits overhanging end of load to sink slowly to blocks on the ground.

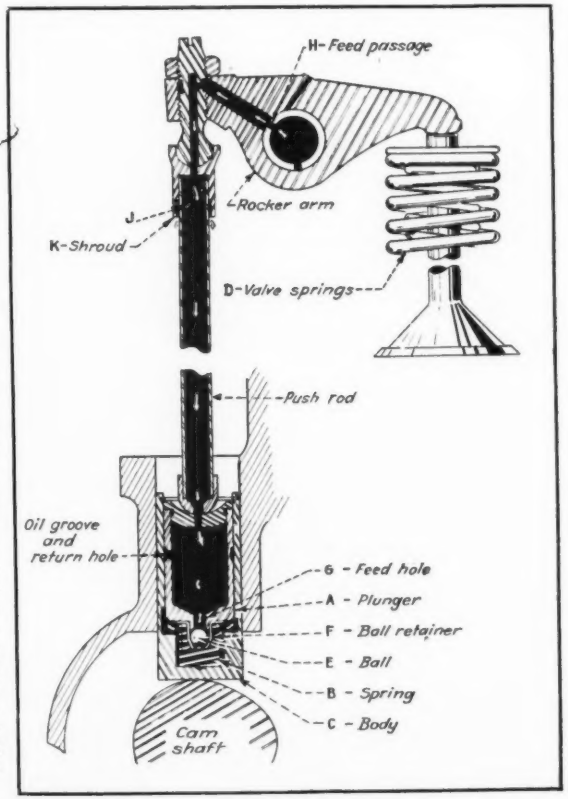
MOVING THE TRUCK forward places other end of lumber in position for lowering. Dual hydraulic controls are placed on rear panel and in cab.

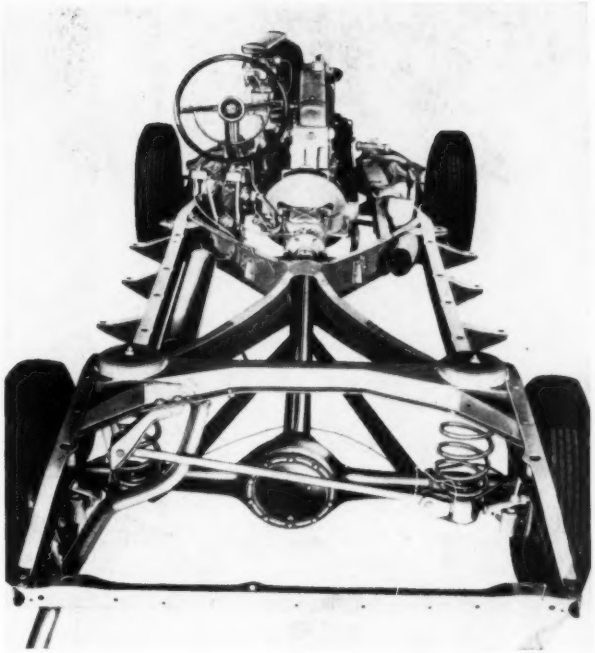
CURVED WINDSHIELDS and greater window area are featured on the Series 50 and 70 Buick. While the length of the wheel base has been reduced, full passenger leg room is permitted by recessing footrests into the floor.

1949 Buick

Twenty-two percent more glass area has been incorporated in the Buick car for 1949. Thicker, more rigid door posts and more extensive use of double-walled construction have made the increased visibility possible. Dynaflow torque converter transmission (Product Engineering—Feb. 1948, p. 96) formerly available only on Series 70 cars is now offered on the Series 50. The basic Dynaflow unit is used on the Series 50 also, but with a torque converter scaled in size for the smaller engine. Exceptional quietness and smoothness of engine operation have been achieved through the use of hydraulic valve lifters. Oil has replaced wax as insulation for the ignition coil which is mounted directly on the engine to shorten the lead to the distributor. This was done to lessen radio interference.

HYDRAULICALLY OPERATED valve lifters automatically maintain the adjustment of valve tappets at zero clearance and compensate for any variations in linkage lengths caused by temperature changes or wear. When valve is closed, combination of spring and oil pressure expands lifter keeping tappet body in constant contact with cam base circle. As the cam starts to raise the lifter, ball check valve closes trapping oil in the lower reservoir. This trapped oil acts as a solid link and raises the plunger with the body which in turn moves the valve train to open the valve.





ALL FUSES are mounted on a master panel which is accessible either from underneath the instrument panel or through an access plate from the engine side of the dash. Fuses for heater, blower, direction signal, stop lamps, clock and dome lamp circuits are shown here.

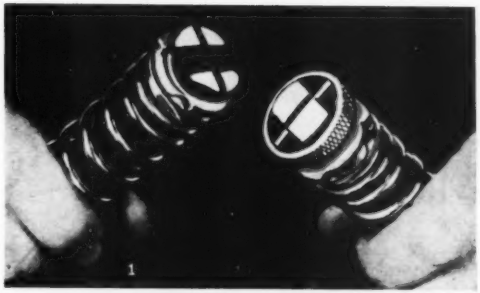
BOX-SECTION CROSS MEMBER under the front of the rear seat ties together the lower wheel houses and rocker panels.

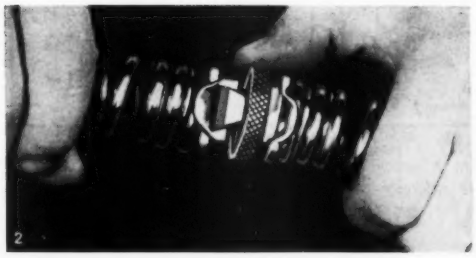
Automatic Coupling Device for Flexible Shafts

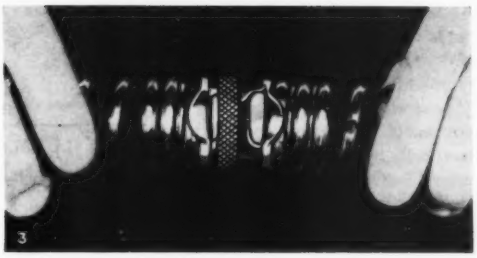
1 Basic dovetail design of coupling is shown in this view of male and female ends. Coupling was developed by Kollman Manufacturing Co., Erie, Pa. for use on flexible shafts of power driven pipe cleaning machines.

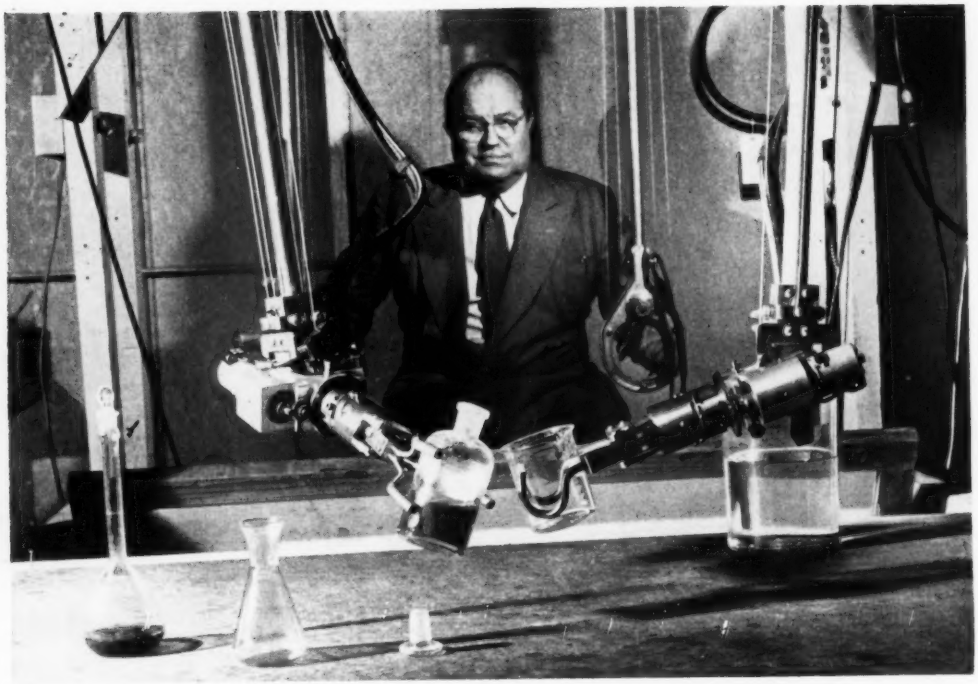
2 Knurled ring and locking bar of male assembly is pulled back to allow keystone flange to slide into female slot making coupling secure endwise.

3 On release of knurled ring, locking bar slips into milled slot in the female end securely locking the coupling transversely. Locking device may be actuated by spring, air pressure, hydraulic pressure or by a solenoid.





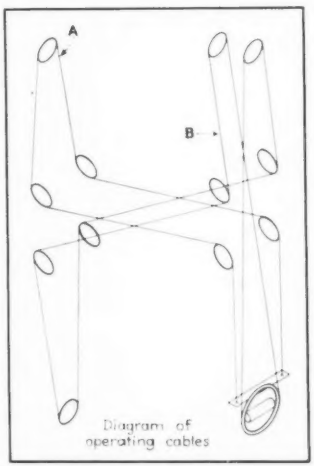




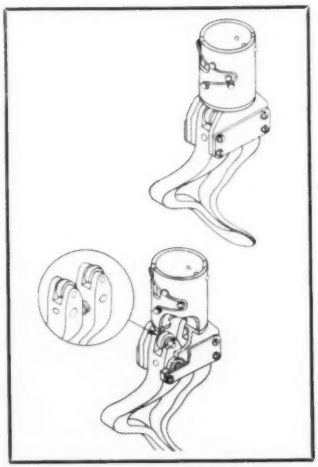
TWO MANIPULATORS may be operated simultaneously. This demonstration unit does not include the concrete barrier and periscope viewer used in actual experimental work with dangerous radioactive materials.

Remote Control Manipulator

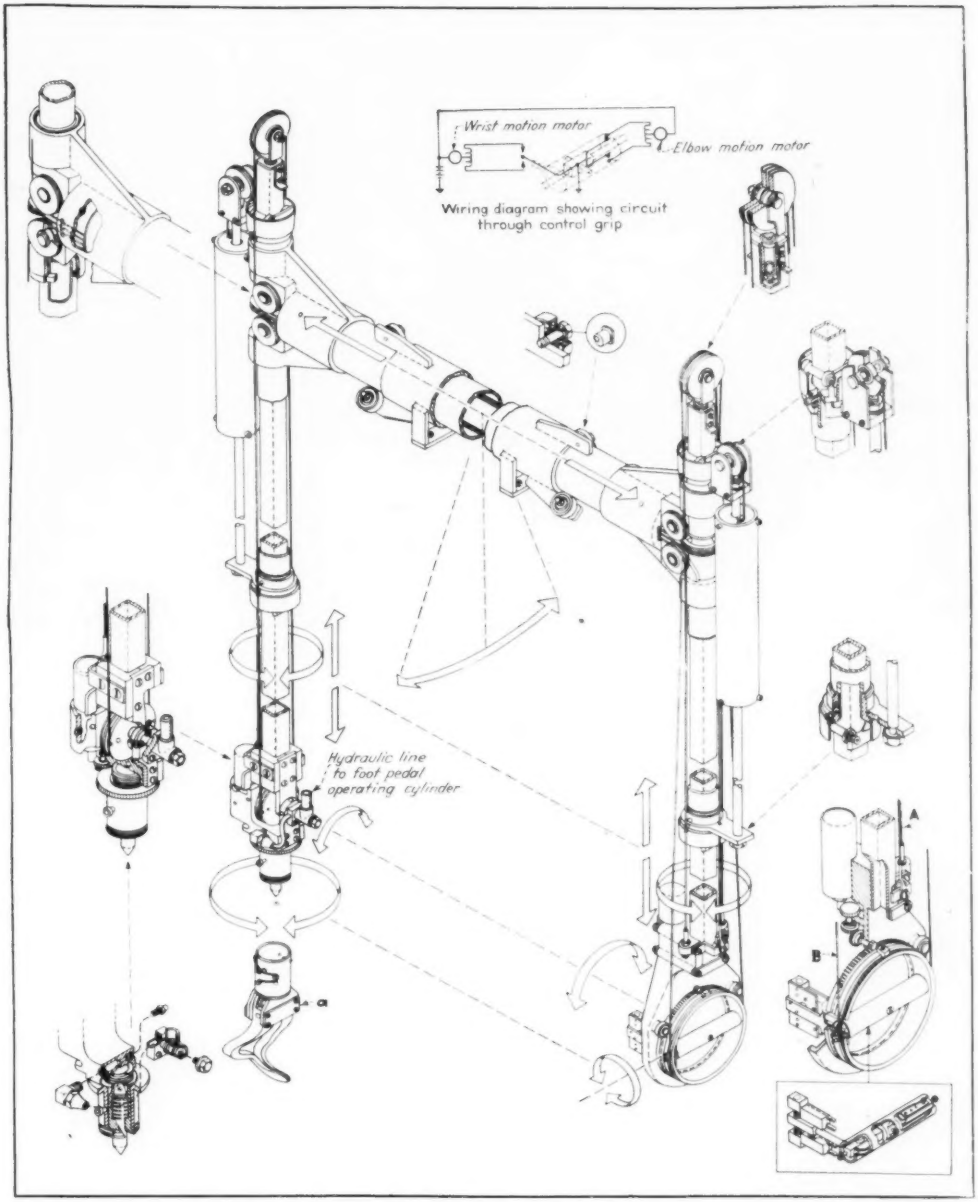
Cable systems transfer principal motions from operation to tool in the manipulator designed by John Payne of the General Electric Company. Other motions are obtained by movement of the whole unit or by control of small motors. Interchangeable tools are actuated hydraulically by a foot pedal. Shaded arrows indicate corresponding motions of control handle and tool unit.



WHEN HANDLE UNIT is raised or lowered, cables *A* and *B* move the tool unit. Cable *B* also transmits rotation about a horizontal axis just above the tool holder. A third cable loop transmits rotation about vertical axes.



GRIPPING UNITS can be changed by remote control. To remove the gripper, it is restrained from rotating. Downward pressure and rotation then unlocks and at the same time, disengages the bayonet joint.



TRANSMITTING HANDLE operates two switch elements. Rotating the handle slightly about the axis of the drum energizes a motor and gear reducer connected to the drum surrounding the handle. Rotation of this drum moves cable *B* and imparts a corresponding rotation to the operating assembly. Rocking handle from front to back energizes another motor which can revolve the gripping assembly. The operating assembly terminates in a revolvable sleeve. Grippers shown are adapted to gripping glassware and similar objects. The gripper fingers are closed by pressure of the conical piston rod of the hydraulic cylinder on the rollers in their upper portion.

HIGH-STRENGTH hard-to-machine alloys form the bulk of the wide variety of parts made by precision investment casting.

Design of Precision Cast Parts

Design rules for reducing die cost and casting difficulties.

J. F. HENDERSON
Precision Casting Section
Allis-Chalmers Mfg. Company

DURING THE WAR the precision casting process was adapted to the production of ferrous and nonferrous parts. The main objective was to relieve the load on machine tools. Manufacturing cost was secondary. Today precision castings must stand on their own merits in a competitive market and the claims of the numerous advantages of precision castings are undergoing closer scrutiny.

Because the precision casting process is new in the industrial field, designers are not completely aware of its possibilities and limitations. Many parts are cast to designs intended for other manufacturing processes. The result is that they cost more. But with slight design changes these costs often can be brought in line.

The chief advantage of precision casting as a production process is that it can be used to cast intricate shapes in non-ferrous and ferrous metals, including high-strength, high-temperature steels, to reasonably close tolerances and surface finishes. Hence it permits the production of finished parts requiring a minimum of machining. Assuming that three nearly identical parts are made by precision casting, sand casting or machining, the precision cast part, as-cast, will cost more than the sand cast part, as-cast, or the raw stock for the machined part. So to end up with comparable final costs for all three parts, it follows that machining costs for the precision cast part must be less than for each of the other two. By proper design, precision cast parts that satisfy this requirement, can be produced.

In Fig. 1 are shown two parts, cast in aluminum bronze, which need little machining. One part has a $3\frac{1}{2}$ in. lead Acme-type male double-thread that engages the female thread in the other part in the as-cast condition. The casting cost for these parts is about three times that for sand castings, but the saving in tooling and machining more than offsets the difference.

Precision castings are used frequently for parts made of material difficult or impossible to machine because of its hardness or work hardening characteristics. One example is gas turbine blades for jet engines. On these, the surface finish of the blades in the as-cast condition, is fine enough except for buffing.

Precision casting can be used also to make parts with interior cavities connected to the outer surface of the part by small openings, particularly if the cavity and openings cannot be machined or tolerance requirements cannot be met by a cored sand casting. For these, the core in the wax pattern die can be made with interlocking segments that can be withdrawn through the openings, or the pattern can be made in two halves, joined together.

Possibly because of early claims

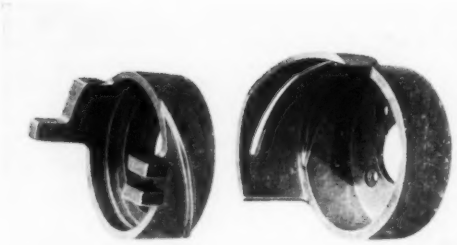


Fig. 1—Mating precision-cast aluminum-bronze parts that require little machining, resulting in reduced production costs.

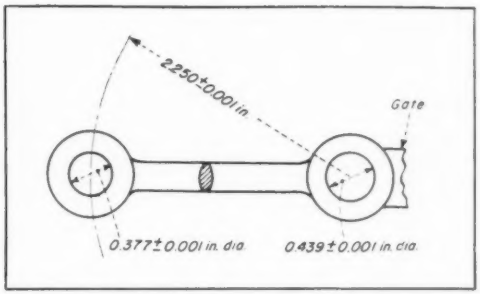


Fig. 2—Close tolerance dimensions on precision cast parts require special casting procedures, to compensate for shrinkage.

Fig. 3—Soft metal die and wax patterns made from it. Patterns are assembled in groups and packed in investment material.

Fig. 4—Steel die with multiple inserts make wax pattern for a rotor disk. Individual die segments form rotor blades.

made by casters, designers expect greater dimensional accuracy than it is possible to obtain in production. Parts can be cast to overall tolerances from ±0.003 to ±0.008 in. per in., depending on their size. This does not apply to dimensions measured on the parting line. Here accuracy depends on the match of the two halves of the steel wax pattern die or the amount of flash at the parting line if a soft metal die is used, even though the amount of flash is small. Surfaces at gates also are difficult to hold to close limits. Factors offsetting the dimensional accuracy of cast parts are shrinkage of the wax pattern, mold expansion during curing, and metal shrinkage.

For most parts, minimum wall thickness should not be less than 0.045 in. On tapered parts, such as turbine blades, edge thickness may be as little as 0.013 inch.

Holes can be cast to the same tolerances as the rest of the part, i.e., ±0.003 to 0.008 in. per in. Small diameter holes can be cast in thin sections. Hole diameters in a ¼ in. section may be as little as 0.050 in. If cast holes are reamed, the center distance from the hole to a reference should show a tolerance of not less than ±0.003 in. However if the alloy used is readily machineable, it is better to drill the hole later.

Often holes are cored in parts to reduce shrinkage that might otherwise occur, both in the wax pattern and the cast part. In Fig. 2, the link shown has a 0.377 in. hole, which is cored, and a 0.439 in. hole, which is cast solid. By coring the 0.377 in. hole, a more uniform section is produced and only one gate is required for feeding the metal to the mold. After casting, the cored hole is reamed. The 0.439 in. hole is then located from the 0.377 in. hole and drilled and reamed. In this way the center distance between holes can be held to 2.50 ± 0.001 in.

Threads should not be cast unless the pitch diameter is large, a loose fit is acceptable, and the length of thread is short. Even these may need chasing to true them up and to remove the small pimples of metal that form at the root of the thread during casting. However, if the metal cast is not machinable, it may be more economical to cast threads and finish machine them than to machine the whole thread.

If the designer is satisfied that the part being considered can be best produced by precision casting, he should visualize the problems involved in each of the three major steps comprising the casting process with a view toward a design that will yield the best and most economical casting. These steps are: (1) Manufacture and operation of the wax pattern die, (2) assembling the wax patterns with the proper wax gates, risers, and sprue, (3) investing the patterns, preheating, pouring, and shaking out the castings.

Wax patterns are made by injecting liquid wax under moderately high

pressure into a closed die. The wax pattern dies used are machined in steel or are made by flowing a low melting point metal around a metal master pattern. The soft metal is cast around the master pattern in two operations to get two die halves with a parting line that allows no back draft in either half of the die. Fig. 3 shows a wax pattern being taken from a typical soft metal die. Fig. 4 shows a steel die with a wax pattern made from it; also the finished casting. This dies is unusual because of the many inserts required to form the blades. As shown, each insert is movable and can be drawn away from the wax pattern radially. Soft metal dies are used mostly for small quantity jobs, for parts with irregular parting lines and for complex shapes that make the cost of a steel die prohibitive. However, steel dies are preferred if production justifies their cost.

Fig. 5 shows a recently developed machine for rapid production of wax patterns. The die in the machine, in addition to its upper and lower halves, has a bar across the back of the upper half that moves downward with respect to the upper half at the end of the opening stroke. Eight core pins passing through this bar are drawn back after the die is opened, stripping the wax off the pins. The die is made of steel.

Design considerations that affect die cost are:

1. Simplicity of design.

As in all manufacturing processes, production costs can be controlled by the designer.

2. Straight parting lines.

Irregular parting lines add to die cost. Also more flash will be cast if steel dies have out-of-plane parting lines. If the part cannot be designed with straight parting lines, figure on soft metal cores. In these, the second half of the die is made by flowing the liquid die metal around the master pattern, which is embedded in the other die half up to the desired parting line. In this way, the parting line is accurately produced.

3. Avoid loose cores.

If possible design the part so that cores are part of the die. Loose cores may shift, particularly in soft metal dies, which wear rapidly.

4. Avoid oblique cores.

Cores that can be withdrawn perpendicular or parallel to the parting line simplify die design and speed wax pattern production.

5. Allow sufficient draft.

Make sure wax patterns can be removed easily from the die. One-quarter to one-half degree is sufficient.

6. Locate the parting line away from dimensions that must be held to close limits. Dimensions across the parting line cannot be cast accurately.

7. Design for a compact part.

Large wax patterns, particularly those with thin sections, may warp when ejected from the die.

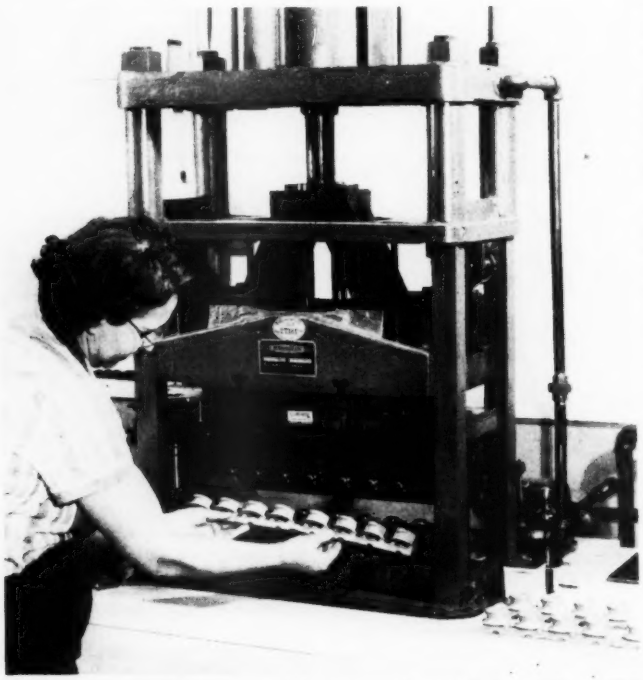


Fig. 5—Pattern group being removed from automatic wax-injection machine. With multi-cavity water-cooled dies, machine increased pattern production 500 percent.

Part Design

In addition to the effect of part design on die design and cost, part design affects the investment mold and the casting made from it.

Investment molds are gated in the same way as sand molds, hence the following rules apply:

1. Design the part for uniform or near-uniform section thickness throughout.

2. Avoid abrupt changes in section thickness, especially at junctions.

3. Break a sharp corner with a radius, but do not make the radius so large that a heavy section is created.

4. Avoid deep recesses and long slender cores. It is hard to clean these of investment material after casting.

5. Avoid large flat surfaces. Some surface imperfections and pits cannot be avoided. Those show up on flat surfaces but are not as noticeable if the surface is crowned, ribbed or broken some other way.

The foregoing rules are elementary but important. Beyond these is the requirement that the designer work closely with the caster on these problems for which there are no pat solutions.

With proper heat treatment, physical properties can be obtained for precision castings that compare favorably with those for forged or rolled sections in the same metal. Fatigue, yield, and ultimate tensile strengths are good, but castings are slightly less ductile than forged or rolled shapes.

In general, the machining properties of precision castings are very similar to those of sand cast materials. Thin sections are harder than thicker ones. Also, occasional hard spots may occur if careful melting practice is not followed. Since precision castings are poured into hot molds, their rate of cooling, unless deliberately accelerated, is much slower than that for sand castings; this results in larger grain size, but also in sounder, denser castings.

When tool steels, plain high-carbon steels, or heat-treatable stainless steels are precision cast they usually have to be annealed before machining because of the high hardness and low ductility in the as-cast condition. This is especially true of thin sections.

Copper-Base Alloys for Springs—I

General and specific data on the copper-base alloys used for spring materials. Theory of corrosion is outlined and causes of galvanic corrosion and stress-corrosion cracking are discussed. Gages and temper hardnesses in which copper-base alloy wire and strip are available. Workability and possible methods for joining these alloys are included.

HAROLD C. R. CARLSON
Spring Consultant

THE CHEMICAL, mechanical and electrical properties, including resistance to corrosion of the copper-base alloys are well known to metallurgists. Design engineers, however, have not usually spent sufficient time in studying these characteristics. Consequently an engineer will frequently favor unjustifiably one alloy more than others, thereby overlooking the economics of sound engineering principles and pass up opportunities to use other readily available materials.

Several copper-base alloys are used for springs; each one has some peculiar advantage and its own particular field of application.

Spring-brass, phosphor-bronze and beryllium-copper are the most popular copper-base alloys used for springs. Material specification numbers for these copper-base spring alloys are given in Table I. Phosphor-bronze is by far the most popular of the three because of its excellent spring and electrical properties combined with high corrosion resistance. Spring-brass has the least satisfactory spring characteristics, but it is frequently used where color harmony with other parts in a general assembly is desirable and where low cost is of importance.

Beryllium-copper is a comparatively new alloy. Its unusually good spring properties make it the best of these three materials where endurance and high strength must be coupled with high electrical conductivity. Its higher price and costly manufacturing methods are frequently justified, not only to obtain a part with high electrical conductivity, but because such parts when fixture heat-treated can be held to close tolerances that may save adjustment time during assembly.

Corrosion Resistance

Corrosion can be described as the disintegration or wearing away of metals by certain external agencies. It may be caused by chemical or electrochemical reaction with non-metallic elements in the environment, thereby producing chemical compounds of oxides or salts. Mechanical erosion may also assist the destructive process of corrosion. The amount of corrosion or corrosion rate is commonly expressed in inches of penetration per year (ipy), or in grams of weight lost per square decimeter (or per square meter) per day. All metals corrode with the possible exception of the noble metals such as gold, platinum and others, and even these will discolor under certain conditions.

Copper-base alloys have long been known for their excellent resistance to atmospheric corrosion and to attack by both fresh water and sea water. Spring-brass, phosphor-bronze and beryllium-copper have somewhat similar characteristics in this respect but, of course, some variation exists in their ability to resist attack by certain chemicals. The difference in this property depends upon the composition of the respective alloys.

Corrosion of the copper-base alloys may result in the green color of the carbonate, as usually observed on bronze statues and on copper roofs, the red of their oxides or the black of their sulphides.

For practical purposes, the corrosion resistance of phosphor-bronze and beryllium-copper may be considered the same as that of pure copper. These materials can be used in alcohol, acetic acid, beer, mild brine solutions, cold dilute hydrochloric and sulphuric acids for short periods of time, gasoline and hydro-carbons, organic salts and acids, phosphoric acid, sea air and phenol. Extreme conditions of temperature, concentration, impurities, and aeration will seriously affect the corrosion resistance of these alloys.

Copper-base alloys are not recommended for use in contact with the following reagents: Ammonia, ammonium-hydroxide, cyanide, ferric or mercuric salts, oxidizing acids, sulphur or chlorine gas, but may be used in water treated with chlorine. Tin coatings or nickel plating are employed to protect the base alloys from some types of corrosion. Spring-brass is seldom used successfully in direct contact with active chemical sub-

Table I—Material Specification Numbers for Copper-Base Alloys

When listing specifications always state "to latest revision." Revision letters ordinarily follow last numeral such as 22W5c. Revision letters, because they change frequently, are not indicated in the table. Some specifications contain only chemical composition ranges and entirely omit mechanical properties. The ASTM specifications are the most complete and should be used whenever possible.

Specification	Spring-Brass		Phosphor-Bronze		Beryllium-Copper	
	Wire	Strip	Wire	Strip	Wire	Strip
ASTM	B134 Alloy No. 6	B36 Alloy No. 6	B159 Grade A*	B103 Grades A and C	B197	B194 B195
SAE	——	——	81	77 Grades A and C	4650	——
U. S. Navy	——	47B2 46B6	22W5	46B14	46C10	——
U. S. Army	——	57-172-1C	——	——	Air Corps 11070-A	——
Aero Mat. Spec. AMS (SAE)	——	——	4720	4510	——	——
U. S. Federal	QQ-W-321 Grade C	QQ-B-611 Comp E	QQ-W-401	QQ-B-746 Grades A and B	——	——

* Grades C and D are also suitable for wire coil springs, but are not always readily available.

stances. In selecting a material to resist specific solutions, a spring consultant, a spring manufacturer or a producer of copper-base alloys, should be consulted.

Galvanic Corrosion

Copper-base alloys, when joined with aluminum or steel, in damp surroundings are attacked by another type of corrosion known as galvanic corrosion. When two different metals widely separated in the galvanic series, Table II, touch each other in water, in acid, in a moist corrosive atmosphere or in liquids capable of carrying current, one of the metals will corrode while the other will be protected. This destructive change is caused by an electrochemical reaction that is promoted by the galvanic voltage set up in the system. The corroding metal acts as an anode, the protected metal as a cathode and the corrosive influence as an electrolyte. Copper-base alloys are cathodic and protected while causing corrosion to occur on steel, stainless steel, aluminum, iron, magnesium, zinc and their alloys.

The severity of corrosion is dependent on the relative anodic and cathodic areas, strength of electrolyte, temperature and polarization effects. Variations in the composition of the corrosive media also affect the amount of galvanic corrosion.

A good method to reduce galvanic corrosion is to plate the copper-base alloy with cadmium, although an ordinary coat of paint or enamel will usually give adequate protection. In many applications, galvanic attack can be reduced to negligible proportions by simply avoiding direct contact of the two dissimilar metals by proper insulation.

Galvanic corrosion between two metals that are near each other in the galvanic series, such as cadmium and steel, would be of little consequence. When two metals that are more widely separated in the series, such as aluminum and copper, are coupled in sea water, galvanic corrosion will noticeably affect the metal nearer the anodic end of the series (aluminum), but the metal nearer the cathodic end of the series (copper) would be galvanically protected from corrosion.

Table II—Galvanic Series For Quiet Sea Water

(Anodic End)	Tin
Magnesium	Nickel
Zinc	Copper and its alloys
Aluminum	Silver
Cadmium	Gold
Iron and steel alloys	(Cathodic End)
Lead	

Table III—Commercial Tolerances on Diameters of Wire, Plus and Minus Inches

Diameter, in.	Spring Brass	Phosphor-Bronze and Beryllium-Copper
Up to 0.010, inclusive	0.0001	0.0002
Over 0.010 to 0.020	0.0002	0.0003
Over 0.020 to 0.030	0.0003	0.0005
Over 0.030 to 0.040	0.0004	0.0007
Over 0.040 to 0.050	0.0005	0.0008
Over 0.050 to 0.060	0.0006	0.0010
Over 0.060 to 0.080	0.0008	0.0015
Over 0.080 to 0.150	0.0010	0.002
Over 0.150 to 0.500	0.0015	0.002
Over 0.500 to 0.750	0.002	0.003

Table IV—Commercial Tolerances on Thickness of Strip, Plus and Minus Inches

For widths 8 inches and smaller

Thickness, in.	Spring Brass	Phosphor-Bronze and Beryllium-Copper	Beryllium-Copper Special Grade, ASTM B 195
0.004 and under	0.0003	0.0004	0.00025
Over 0.004 to 0.006	0.0004	0.0006	0.0003
Over 0.006 to 0.009	0.0006	0.0008	0.0005
Over 0.009 to 0.013	0.0008	0.0010	0.0006
Over 0.013 to 0.017	0.001	0.0013	0.0007
Over 0.017 to 0.021	0.0013	0.0015	0.0008
Over 0.021 to 0.026	0.0015	0.002	0.001
Over 0.026 to 0.037	0.002	0.0025	0.001
Over 0.037 to 0.050	0.002	0.003	———
Over 0.050 to 0.073	0.0025	0.0035	———
Over 0.073 to 0.130	0.003	0.004	———
Over 0.130 to 0.187	0.0035	0.0045	———

Table V—Commercial Tolerances on Width of Strip, Plus and Minus Inches

Spring-Brass, Phosphor-Bronze and Beryllium-Copper—Slit Strip and Rolled Edge Strip

Width, in.	Thickness, in.	Tolerance
2 and smaller	0.004 to 0.032	0.005
2 and smaller	0.032 to 0.187	0.010
2 to 8 inclusive	0.004 to 0.032	0.008
2 to 8 inclusive	0.032 to 0.187	0.015

Stress-Corrosion Cracking

An unusual form of failure, called "season-cracking," is occasionally observed in some of the copper-base alloys. Phosphor-bronze and beryllium-copper are practically immune to season-cracking or stress-corrosion failures when properly processed. Season-cracking is most prevalent among the brass alloys that are low in copper and high in zinc content. The following combination of conditions may cause such cracks to occur:

1. High internal stresses in the material resulting from cold drawing or cold rolling plus additional stresses caused by forming operations and stresses introduced by external loads.

2. Small traces of ammonia in air. Ammonia is very detrimental to yellow brass. Cracks may be caused to occur in this metal even by the small amounts of ammonia normally present in damp atmospheres such as are usually found in cellars.

3. A composition susceptible to such failures.

4. The length of time under which any or all of the first three conditions exist.

Susceptibility to stress-corrosion cracking can be reduced in several ways:

1. Avoid storing the material in

damp cellars or outdoor locations.

2. Avoid areas where ammonia may be present.

3. Avoid using susceptible alloy (high in zinc) compositions.

4. Use a low temperature (325 to 375 F, 30 to 60 min) stress relief anneal after forming.

Gages

All copper-base alloys for springs are drawn and rolled to the American Wire Gage (same as Brown & Sharpe gage). On drawings and bills of material, the gage number and its decimal gage thickness should be specified whenever possible. The most popular sizes in round wire are from $\frac{1}{2}$ to $\frac{1}{16}$ in. dia, but smaller diameters ranging to 0.005 in. and larger diameters ranging to $\frac{1}{2}$ in. are both available. Intermediate and half gages are sometimes available also.

Strip with rounded edges is used for frequently deflected flat springs, because slit edges have a tendency to tear under flexure and cause early breakage. Slit edge strip, however, is customarily used for parts that are to be stamped or blanked.

Square and rectangular sections of wire are infrequently used, they are not recommended because of the lack of availability with good spring properties although round wire rolled to a rectangular shape having round edges may be obtained on order.

Strip may be obtained in the American Wire Gage, it is also obtainable in many even three place decimal thicknesses, such as 0.018, 0.020, and 0.022, and in many odd three place decimal figures as well. Some mills will also supply nonferrous materials in the Birmingham or Stub's gage, but stock in this gage with good spring properties is not always readily available.

Commercial tolerances on diameter of wire, thickness of strip and width of strip are given in Tables III, IV and V respectively.

HARDNESS AND TEMPER. Wire made from spring-brass, phosphor-bronze and many other nonferrous materials receives its high tensile strength and hardness by the cold work done in reducing the rods or wire to smaller diameters by cold drawing through hard dies. Flat strip acquires its high-tensile strength and hardness by cold rolling.

The amount of hardness acquired in cold working is frequently called the "temper" or hardness number. The "temper number" is governed by and depends upon the reduction of area from the annealed to the final state; it is equal to the number of American Wire Gage numbers through which the material is drawn or rolled from the annealed to the final state without intermediate annealing. The American Wire Gage is used because the gage numbers have a definite dimensional relationship to each other. In this system the thickness dimension is reduced by approximately 50 percent for every six gage numbers; for example, No. 0 is 0.3248 in., No. 6 is 0.1620 in., No. 12 is 0.0808 inch.

The grain size of the material in the annealed condition before drawing or rolling must be accurately controlled to acquire uniformity of temper.

Although both wire and strip are frequently purchased by temper designations, such as the numbers of hardness, they are also obtainable in hardnesses corresponding to Rockwell, Brinell and other standard hardness measurements. The standard hardnesses listed in Table VI have been universally adopted. In specifying the hardness, it should be remembered that the popular Rockwell scales should be used with caution for strip less than 0.020 in. thick. A superficial tester for such thin strip is desirable. Table VII gives recommended Rockwell Scales for copper-base alloy strip.

In the copper-base alloys, hardness readings are seldom taken on round wire smaller than $\frac{1}{16}$ in. dia. A reading taken on smaller diameters may read from 2 to 5 points on the low side depending on the diameter of the wire; the smaller the diameter the larger is the error. As a general guide, the corrected Rockwell hardness readings carefully taken on round surfaces should run as follows: Spring-brass wire 89 to 95B; phosphor-bronze wire 90 to 97B; beryllium-copper wire drawn 4 Nos. Hard, not precipitation hardened 93 to 100B, and for precipitation hardened wire 37 to 41C. Recommended hardness ranges for spring-brass strip, phosphor-bronze strip, and beryllium-copper strip are given in Tables VIII, IX and X, respectively.

Workability of Copper-Base Alloys

WELDING. All the common welding methods, with proper care, can be used in joining the copper-base alloys. Cleanliness of the surfaces to be welded is essential to assure that no oxide on the surfaces will interfere with fusion.

Brass is welded best with oxyacetylene welding, but carbon-arc and resistance or spot welding also can be employed. Phosphor-bronze can be welded with carbon-arc or metal-arc methods quite successfully; oxyacetylene welding is not recommended, but

Table VI—Standard Hardness Designations

For All Copper-Base Wire and Strip

Hardness or Temper	Reduction in American Wire Gage Numbers. (Temper or Hardness Numbers)	Strip, Percent Reduction in Thickness	Wire, Percent Reduction in Area
Eighth Hard	$\frac{1}{2}$	——	10 9
Quarter Hard	1	10 95	20 7
Half Hard	2	20 70	37 1
Three Quarter Hard	3	29 40	50 0
Hard	4	37 10	60 5
Extra Hard	6	50 15	75 0
Spring Hard	8	60 50	84 4
Extra Spring Hard	10	68 65	——

Example: To obtain a strip of No. 16 (0 0508 in.) American Wire Gage with an Extra Hard Temper (6 Nos Hard), a mill would take a 6 number heavier strip, namely No. 10 (0 1018 in.), anneal to refine the grain structure and roll to No. 16 (0 0508 in.) without intermediate annealing operations.

Table VII—Recommended Rockwell Scales for Strip

In certain thickness ranges, two or more scales may be used.

Strip Thickness, in.	Scale
0 010 to 0 020	15-N Superficial
0 010 and larger	30-T Superficial
0 020 and larger	30-N Superficial
0 020 to 0 050	"A" Scale
0 040 and larger	"B" Scale
0 050 and larger	"C" Scale

resistance or spot welding is frequently employed. Beryllium-copper is readily welded by the carbon-arc method; gas-fusion and metallic-arc welding are not recommended, but resistance or spot welding can be used.

Welding operations on springs must be done with extreme care because the welding heat will destroy the spring temper of the material at the weld. An occasional spot of weld, or tacking the end coil of a spring to a plate, is about all the welding that is usually done to springs. It is not possible to expect that a welded broken spring will withstand repeated deflections without breaking.

BRAZING. Spring-brass and phosphor-bronze can be brazed. But no thoroughly satisfactory technique has been developed for brazing beryllium-copper. Silver alloy brazing is best for brass. Phosphor-bronze alloys are readily brazed with torches, in furnaces and by electrical resistance. Silver brazing alloys and copper-zinc alloys are used with a borax or boracic-acid flux. The brazing heat, however, will cause all copper-base alloys to lose their spring temper near the brazing area unless special care is taken.

SOLDERING. All the copper-base alloys can be soft soldered satisfactorily, because the low melting temperatures used for relatively short periods do not destroy the spring temper. Surfaces to be soldered should be carefully cleaned either by chemical or mechanical means such as scraping or scouring. Customary fluxes or commercial soldering compounds can be used. A solder containing 90 percent tin and 10 percent zinc is recommended for strong joints. Silver soldering frequently called brazing can also be done with the low melting point grades. Extreme care must always be taken to avoid losing the spring temper when soldering the copper-base alloys.

STAMPING. In strip form, the copper-base alloys are especially suitable for stamping, blanking and bending operations. Formed parts are easily bent to intricate shapes. They are used in switches, fuse plugs, receptacles and in other electrical apparatus.

CLEANING. Greases, oils, lubricants and dirt can be cleaned from copper-base alloys by immersing the pieces in hot alkaline solutions or by washing with kerosene, gasoline or other solvents. Vapor degreasing can also be used. Tarnish and corrosion effects can be removed by pickling for one to seven minutes in a sulphuric acid pickle consisting of 4 parts of water and one half to one part of sulphuric acid at a temperature from 100 to 160 F. This solution is also frequently used at room temperatures.

A glossy finish can be obtained by immersing the parts in a bright dip solution consisting of one part of water, four parts of nitric acid, eight parts of sulphuric acid and with one ounce of hydrochloric acid for each five gallons of solution. This bright dip can be used at room temperature, with a soaking time range of 5 sec to 5 min. Many other solutions are also used for bright dipping.

It is important to rinse the parts well immediately after all pickling operations. Also, the immersion time in acids should be kept as short as possible to reduce acid attack on the par-

Table VIII—Hardness of Spring-Brass Strip, ASTM B36 Alloy No. 6

Condition			Thickness, in.	Rockwell Hardness	
Temper	Nos. Hard	Reduction By Rolling, Percent		Superficial 30-T Scale	B Scale
Hard	4	37.10	0.012 to 0.020	70 to 74	———
			0.020 and larger	———	79 to 86
Extra Hard	6	50.15	0.012 to 0.020	74 to 77	———
			0.020 and larger	———	85 to 91
Spring Hard	8	60.50	0.012 to 0.020	76 to 78	———
			0.020 and larger	———	89 to 93
Extra Spring	10	68.65	0.012 to 0.020	77 to 79	———
			0.020 and larger	———	91 to 95

Table IX—Hardness of Phosphor-Bronze Strip, ASTM B103

Condition			Thickness, in.	Rockwell Hardness	
Temper	Nos. Hard	Reduction By Rolling, Percent		Grade A	Grade C
Hard	4	37.10	0.010 to 0.030	69 to 75 (30-T)	73 to 80 (30-T)
			0.020 to 0.040	80 to 88 B	89 to 95 B
			0.040 and larger	82 to 90 B	91 to 97 B
Extra Hard	6	50.15	0.010 to 0.030	73 to 78 (30-T)	77 to 82 (30-T)
			0.020 to 0.040	86 to 92 B	93 to 98 B
			0.040 and larger	88 to 94 B	95 to 100 B
Spring Hard	8	60.50	0.010 to 0.030	75 to 79 (30-T)	78 to 83 (30-T)
			0.020 to 0.040	88 to 94 B	95 to 100 B
			0.040 and larger	90 to 96 B	97 to 102 B
Extra Spring	10	68.65	0.010 to 0.030	76 to 80 (30-T)	79 to 83 (30-T)
			0.020 to 0.040	89 to 94 B	96 to 101 B
			0.040 and larger	92 to 97 B	98 to 103 B

Table X—Hardness of Beryllium-Copper Strip ASTM B194 and B195

Condition	Cold Rolled Condition (Not precipitation hardened)		Cold Rolled and Precipitation Hardened			
	B Scale	Superficial 30-T Scale	C Min	A Min	30-N Min	15-N Min
Cold rolled	80 max	68 max	33	67	53	77
C R and solution treated and rolled ¼ hard	72 min	62 min	35	68	55	78
C R and solution treated and rolled ½ hard	82 min	69 min	37	69	57	79
C R and solution treated and rolled hard	93 min	77 min	39	70	59	80

ent metal. Too long a period in acid will reduce the size of the cross-section, thus resulting in lower permissible loads and in an increase in expected deflection.

SHOTPEENING. Highly stressed springs made from copper-base alloys and subjected to shotpeening may acquire an increase in fatigue life up to 1,000 percent. The process consists of peppering the surface of the springs with small round hardened steel shot about 0.015 in. or larger in diameter. This shot, hurled with tremendous force by compressed air or by centrifugal force, accomplishes four operations:

1. Cleans the surface and dulls burrs.
2. Hammers smooth the microscopically small surface irregularities.
3. Produces a cold forging effect that work hardens the surface.
4. Sets up beneficial compression stresses in the outer surface layers that must be overcome before fatigue can cause breakage. This operation is the most important of the four.

Springs for long life made from copper-base alloys should be shotpeened whenever their design incorporates the use of high stresses combined with severe operating service. Light sections of wire less than $\frac{1}{16}$ in. dia and thin strip less than 0.010 in. thick may distort, therefore, they are not usually subjected to shotpeening. Extension springs and closely wound torsion springs are not recommended for the shotpeening operation because the small steel shot becomes trapped between the coils and its removal is quite difficult and expensive.

Heat-treating and stress relieving treatments should be completed before shotpeening, inasmuch as heating after shotpeening relieves in a large measure the desirable compressive fore-stresses in the surface layers.

After shotpeening the surface of the material is somewhat mottled and does not have the bright luster usually associated with copper-base alloys. Minute particles of steel shot may at times adhere to the surface and unless removed may cause small spots of rust to form. But the additional benefit of longer fatigue life certainly warrants the use of shotpeening. The cost is nominal as it is possible to shotpeen from 100 to 300 lb of average size springs in from 8 to 15 minutes.

Allowable Working Stresses

Allowable stress values used in the design of springs of a given material depend upon many qualifications such as type of springs, operating temperature, ratio of spring diameter to wire diameter, rapidity and regularity of deflections, shock loads, corrosive conditions, wire size and most important the stress range. The allowable stresses recommended in Table XI are for general guidance only. Special applications that include conditions other than normal require special attention and analysis. The values given in Table XI apply to springs not subjected to high temperatures, shock loads, or other unusual conditions. The three values recommended for each material, based upon light, average and severe service, have proved effective for long periods of service in many spring applications.

When designing springs required to give good dependable service, the stresses should be calculated by the conventional formulas modified to include the curvature correction (Wahl) factor based upon the spring index. The maximum stress thus calculated should not exceed the allowable stress values recommended for the given type of service. The stress range from the initial to the final stress will to a great extent also determine the fatigue life. Long ranges producing large differences in stress will reduce the life, whereas short ranges even with high stresses tend to increase it.

Fatigue life of a spring may be considered "infinite" if the spring will withstand ten million cycles of deflection; "long" if it will withstand between one million and ten million; "average" if between one hundred thousand and one million; and "short" if between ten thousand and one hundred thousand cycles. Highly stressed springs will frequently sustain one thousand deflections before fracture.

This severe service designation covers those applications in which springs are subjected to rapid deflections over long periods of time, as in automobile valves, engine valves and pneumatic hammers. It is not customary, of course, to use copper-base alloys for such severe applications. These alloys are used largely in average service and in corrosive surroundings, or to carry electrical current. Average service applies to a normal frequency of deflection such as in brakes, motors, machine tools and switches. The light service category is for springs that are statically loaded or are subjected to less than 10,000 slow, intermittent deflections during their lifetime, as in safety devices, emergency equipment, fire fighting apparatus, bomb fuses and in one-time applications.

EDITOR'S NOTE: Part II of this article will be presented in the March number of PRODUCT ENGINEERING. This part will discuss the mechanical properties of spring-brass, phosphor bronze, beryllium-copper and other copper-base alloy wire and strip stock, also the properties obtained by cold work and heat-treatment, and the field of application for each alloy.

Table XI—Allowable Working Stresses for Copper-Base Alloys

Material	Modulus of Elasticity, E in tension G in torsion	Allowable Stress, psi			
		Type of Service	Compression Springs	Extension Springs	Flat, Cantilever, Torsion, and Clock Type
Spring-brass, spring hard	E = 15,000,000 G = 5,000,000	Light	40,000	35,000	70,000
		Average	30,000	25,000	50,000
		Severe	Not used	Not used	Not used
Phosphor-bronze spring wire	E = 15,000,000 G = 6,000,000	Light	50,000	45,000	90,000
		Average	40,000	35,000	70,000
		Severe	30,000	25,000	50,000
Beryllium-copper, precipitation hardened	E = 19,000,000 G = 7,250,000	Light	65,000	55,000	100,000
		Average	50,000	45,000	85,000
		Severe	40,000	35,000	70,000

Use E for springs subjected to tensile stresses caused by bending, such as torsion, flat, cantilever, clock and power springs.
Use G for springs subjected to torsional stresses, such as compression and extension springs and rods used in torsion.

(*a*) All stresses may be increased 20 percent for wire diameters less than 0.020 in., and increased 10 percent for wire diameters between 0.020 and 0.057 inch.

(*b*) For suddenly applied loads, the stresses should be reduced 50 percent.

(*c*) For temperatures between 150 to 212 F the stresses for spring-brass and phosphor-bronze should be reduced 10 percent; from 212 to 275 F, reduced 20 percent. No reduction is required up to 300 F for beryllium-copper.

(*d*) The stress values given include the Wahl curvature correction factor for average and severe service. The factor is infrequently used for static loading and for light service.

(*e*) The modulus of elasticity of beryllium-copper may be increased approximately 10 percent by prolonged heat-treatment.

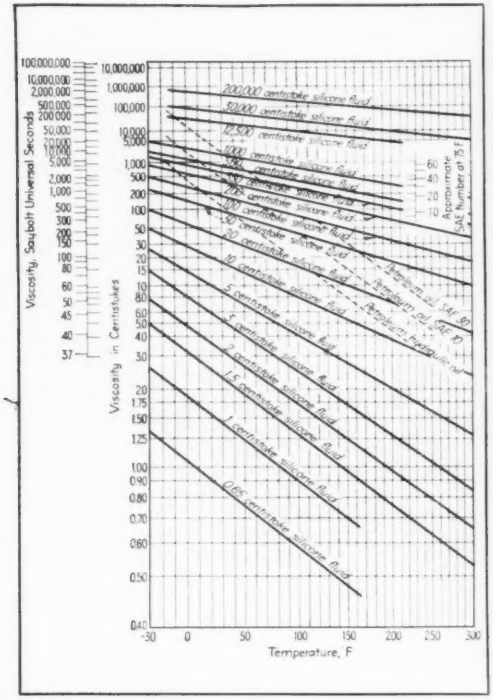


Fig. 1—Viscosity-temperature slopes for silicone fluids (DC 200) and petroleum oils determine usefulness in applications.

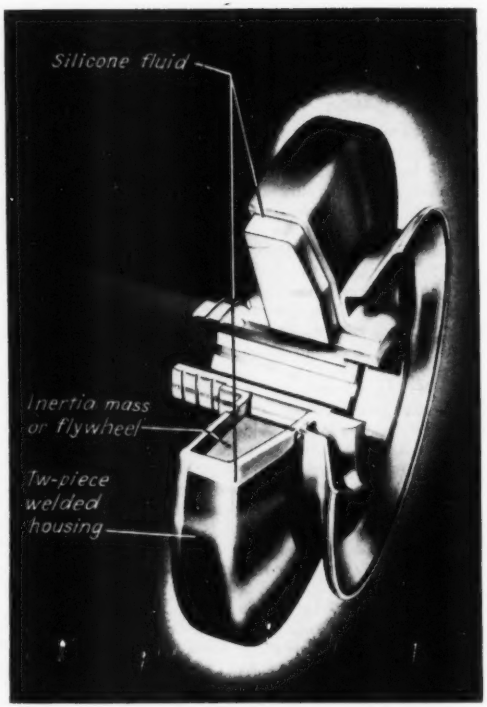


Fig. 2—High viscosity silicone fluid makes possible this simple torsional vibration dampener for auto and diesel crankshafts.

Silicone Fluids In Hydraulics and Lubrication

Excellent stability, resistance to breakdown under mechanical shearing, chemical resistance and viscosity-temperature behavior make the methyl silicone fluids especially suitable for a variety of damping, hydraulic, lubricating and dielectric applications.

T. A. KAUPPI, Manager Product Engineering
C. C. CURRIE, Manager Fluids Section, Product Engineering Laboratories
Dow Corning Corporation

LIQUID SILICONE POLYMERS are produced in a wide range of viscosities depending on length of the molecular "chain", and in several different types, depending on the kind of organic radicals attached to the silicon atoms. One series of fluids—the methyl silicones (DC 200)—has found wide engineering use.

The methyl silicone fluids are clear odorless liquids. In contrast to the petroleum oils, they are only about 40 percent organic. Probably their inorganic core of silicon and oxygen is responsible for their unusual properties, among which is low change in viscosity per unit change in temperature, the lowest of any known liquid. This chemical structure is also responsible for their stable viscosity-temperature behavior, shear resistance, and oxidation and heat resistance—many times more stable than organic liquids. These properties, coupled with their extremely low freezing points, make them particularly useful in hydraulic applications, in vibration damping devices, as lubricants and as liquid dielectrics.

Physical Properties

Methyl silicone fluids are produced in viscosities ranging from 0.65 to one million centistokes at room temperature. All fluids in this viscosity range have the same chemical structure and the same general properties. However, as can be seen in Table I, physical properties of these fluids approach a practically constant value as the polymer size or viscosity "grade" approaches 100 centistokes. There is

Table I—Physical Properties of Silicone Fluids (DC 200)

Viscosity		Viscosity-Temperature Coefficient[1]	Dielectric Constant[2]	Freezing Pt.		Boiling Pt.			Flash Pt.[3] Min. deg F	Thermal Conductivity[4]	Specific Gravity 25 C/25 C	Refractive Index at 25 C	lb/gal at 25 C
						Temperature							
Cstks* at 25 C	SSU** at 100 F			C	F	C	F	Pressure mm Hg					
0.65	28	0.31	2.18	−68	−90	99.5	211	760	30	0.00024	0.761	1.375	6.35
1.0	29	0.37	2.32	−86	−123	152	305	760	110	0.00024	0.818	1.382	6.84
1.5	30	0.46	2.40	−76	−105	192	377	760	160	0.00025	0.852	1.387	7.11
2.0	31	0.48	2.46	−84	−119	230	446	760	175	0.00026	0.871	1.390	7.27
				Pour Point[4]									
3.0	33	0.51	2.52	−65	−85	70–100	158–212	0.5	215	0.00027	0.896	1.394	7.48
5.0	39	0.55	2.58	−65	−85	120–160	248–320	0.5	275	0.00028	0.918	1.397	7.67
10	52	0.57	2.65	−65	−85	>200	>392	0.5	325	0.00032	0.940	1.399	7.85
20	80	0.59	2.68	−60	−76	>200	>392	0.5	520	0.00034	0.950	1.400	7.93
50	185	0.59	2.72	−55	−67	>250	>482	0.5	525	0.00036	0.955	1.402	7.93
						Volatility[6] after 48 hr							
						at deg C	at deg F	percent					
100	350	0.60	2.74	−55	−67	200	392	<2	600	0.00037	0.968	1.4030	8.08
200	720	0.62	2.74	−53	−63	200	392	<2	600	0.00037	0.971	1.4031	8.10
350	1250	0.62	2.75	−50	−58	200	392	<2	600	0.00038	0.972	1.4032	8.11
500	1750	0.62	2.75	−50	−58	200	392	<2	600	0.00038	0.972	1.4033	8.11
1000	3500	0.62	2.76	−50	−58	200	392	<2	600	0.00038	0.973	1.4035	8.12
				Solidification Temperature									
12,500	45,000	0.58	2.82	−46	−51	200	392	<2	600	0.00038	0.973	1.4035	8.12
30,000	115,000	0.61	2.77	−44	−47	200	392	<2	600		0.973	1.4035	8.12

[1] $\frac{V210\ F}{V100\ F}$

[2] At 1000 cycles and 25 C. Schering Bridge used to determine dielectric constant according to ASTM D-150-45T.

[3] Open Cup; ASTM D-92-33.

[4] $\frac{\text{gm cal} \times \text{cm}}{\text{sec} \times \text{cm}^2 \times \text{deg C}}$ at 50 C.

[5] Pour point ASTM D97-39, sections 5 to 7.

[6] Percent weight loss of a 35 to 40 gram sample after heating 48 hr at 200 C in a 150 milliliter beaker having a bottom area of about 3 sq in.

*Centistokes. **Seconds, Saybolt Universal.

practically no change in the physical properties of viscosity grades above 100 centistokes.

VISCOSITY-TEMPERATURE RELATION. The usefulness of a fluid in general engineering applications is determined largely by its viscosity-temperature behavior. All fluids show some change in viscosity with changing temperatures, but no series of organic liquids is as nearly constant in viscosity over so wide a temperature range as the silicone fluids.

Since viscosity-temperature coefficients are frequently misleading and can be applied only over a limited temperature span, the viscosity-temperature slopes of these fluids are shown graphically in Fig. 1. For reference, there are shown viscosity-temperature slopes for a petroleum hydraulic oil, an SAE 10 and an SAE 30 motor oil in broken lines on the same chart. The SAE motor oils are high grade products having a viscosity index (ASTM D 576-41) of over 100. The viscosity of the SAE 30 oil increases from 6.6 at 120 C to 70,000 centistokes at −25 C. In sharp contrast, the silicone fluid, which has a viscosity comparable to that of the petroleum oil at room temperature, increases from 75 at 120 C to 1,300 at −25 C. This is an increase of only 1,225 as compared to 70,000 for the petroleum oil. Thus, the viscosity of the silicone fluid is about 135 times its room temperature same temperature range.

Above 1,000 centistokes, these fluids are even more remarkable for their flat viscosity-temperature slopes. The SAE 30 oil and the 12,500 centistoke silicone fluid both have a viscosity of 35,000 centistokes at −20 C(−4 F). The viscosity of the SAE 30 oil is about 135 times its room temperature value while at −20 C the silicone fluid is less than three times its room temperature value.

The lower members of this series show considerably more change in viscosity with temperature but they still compare favorably with low viscosity organic fluids and they have the advantage of low freezing points.

The practical usefulness of such viscosity-temperature behavior is demonstrated by the performance of these fluids in a torsional vibration damper (Fig. 2). The pounds of force required at −40 and 70 C to actuate the damper against the viscous drag of a high viscosity silicone fluid and a comparable petroleum hydraulic oil are given in Table II. Over a temperature range of 110 C (200 F) the damping effect of high viscosity silicone fluid decreases in the ratio of 3 to 1, compared with a decrease in the ratio of 2500 to 1 for petroleum fluid.

SHEAR STABILITY. The measure of shear stability (Fig. 3) is a comparison

Table II—Damping Force of Silicone and Petroleum Oils

Damping Medium	Pounds of Damping Force	
	at −40 C (−40 F)	at 70 C (160 F)
Silicone (DC 200) fluid, 30,000 centistoke grade	210	70
Petroleum hydraulic oil (very high viscosity)	70	0.028

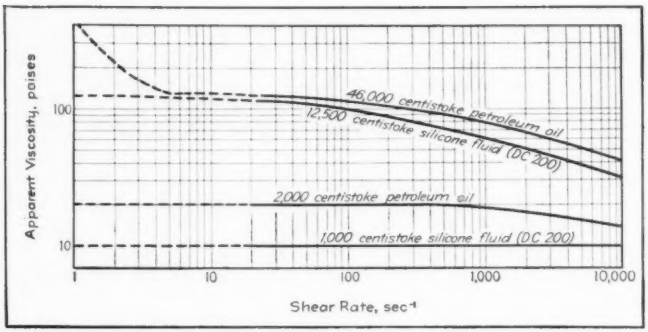


Fig. 3—Apparent viscosity vs shear rate of several petroleum oils and silicone fluids. The silicone fluids suffer no significant loss in viscosity, while the petroleum oils exhibit permanent breakdown caused by mechanical shearing, when held under pressure.

of viscosity before and after long exposure to mechanical shearing. Time, temperature and pressure are factors that affect shear resistance.

Absolute values cannot be given, but comparative performance under identical conditions is significant. A study was made of the performance characteristics of silicone fluids under a pressure of 1,500 psi in an hydraulic system held at 60 C (140 F). After 100 hr of operation involving 18,000 cycles, a petroleum oil used for comparative purposes lost 50 percent of its initial viscosity. A silicone fluid having a viscosity of 71 centistokes at 100 F was subjected to 500 hr of operation involving about 105,000 cycles and still had a viscosity of 70 centistokes. After 5 times as many hours and 5 times as many cycles, this silicone fluid suffered no significant change in viscosity. Such resistance to shear breakdown is important in viscous damping media, hydraulic fluids or lubricants.

BOILING, FREEZING, VOLATILITY. The lower viscosity silicone fluids are volatile liquids with normal boiling points ranging from 99.5 C (211 F) for the 0.65 centistoke grade to 230 C (446 F) for the 2 centistoke fluid.

In viscosity grades above 50 centistokes, these fluids are practically nonvolatile and have no true boiling points. For that reason, volatility values have been determined at 200 C (292 F). Relative volatility is determined by measuring the percent weight-loss of a 35 to 40 gram specimen after heating for 48 hr at 200 C in a 150 milliliter beaker having a bottom area of about 3 sq in. These values are plotted in Fig. 4 to indicate the relative volatility (in percent) of various viscosity grades.

The 0.65 to 2 centistoke fluids have low freezing points, ranging from —68 to —86 C (—90 to —23 F). The 1 and 2 centistoke fluids have the lowest freezing points of any members of the series. Pour points for the 3 to 20 centistoke fluids range from —60 to —65 C (—76 to —85 F). Pour points for the 50 to 100 centistoke fluids range from —50 to —55 C (—58 to —67 F). Use of these more viscous fluids, however, at temperatures below —40 C (—40 F) is not recommended. The solidification temperatures for the 12,500 to 30,000 centistoke fluids are in the order of —44 to —46 C (—47 to —51 F).

Thermal and Chemical Properties

In an open system, silicone fluids with viscosities of 100 centistokes or more are stable for long periods of time at temperatures up to 150 C (300 F). They do not oxidize, form a sludge of decomposition products, or discolor after thousands of hours at such temperatures. Protected from the atmosphere in a closed system, these fluids are equally stable at temperatures in the range of 200 C (400 F). They retain their original properties and are useful at temperatures in the range of 40 to 100 C or 100 to 200 F above the serviceable limits of most other liquids.

Flashpoints of silicone fluids are considerably higher than petroleum oils of equivalent viscosity. Minimum flash points of the lower viscosity fluids range from —1 C (30 F) for the 0.65 centistoke grade to 274 C (535 F) for the 50 centistoke fluid. In the 100 to 1,000 centistoke range, minimum flash point is 315 C (600 F).

However, the flash points given in Table I are, for the most part, temperatures of incipient thermal decomposition. Although the lower viscosity members of the silicone fluids can be ignited in air by an open flame, the non-volatile members of the series will not support combustion unless temperatures approaching their flash points are maintained.

The exceptional oxidation resistance of the fluids is indicated by the fact that there is practically no change in room temperature viscosity when heated in air. Viscosity change in the higher members of the series is less than 10 percent after 16 hr at 200 C (392 F). The lower members of the series are equally resistant to oxidation.

THERMAL PROPERTIES. Silicone fluids in viscosity grades ranging from 0.65 to 50 centistokes have a specific heat of 0.33 to 0.35 cal per gram between 0 and 100 C. Specific heat for 100 to 1,000 centistoke fluids is 0.35 to 0.37 cal per gram. These values are about ⅓ of the values for water and as low as the lowest members of the hydrocarbon series.

As viscosity grade increases from 0.65 to 20 centistokes, thermal conductivity at 50 C (122 F) increases from 0.000236 to 0.000338 gram cal per sec per sq cm per deg C temperature differential for each cm of fluid thickness. In viscosity grades from 20 to 1,000 centistokes, thermal conductivity increases more gradually from 0.000338 to a maximum of 0.000386.

Thermal expansion coefficients are generally applicable only between 0 and 100 C and even within those limits a considerable amount of calculation is involved. Therefore, the actual changes in volume with temperature for representative members of the series have been determined, and are plotted in Fig. 5. Given the volume of any one of these fluids at room temperature, its volume can be calculated at temperature t by multiplying room temperature volume by the volume ratio shown for that viscosity grade.

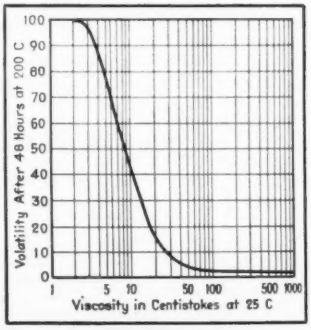


Fig. 4—Relative volatility of various viscosity grades of silicone (DC 200) fluids.

CHEMICAL BEHAVIOR. Silicone fluids are non-corrosive to metals and are generally unaffected by them. In viscosity grades above 100 centistokes they show no action on organic lacquers, coatings or plastics. They usually have no effect on conventional rubbers but after immersion for a period of time there may be a slight leaching of certain plasticizers.

The 1,000 centistoke fluid shows no appreciable change in viscosity after 96 hr at 160 C (320 F) in contact with iron, brass, solder, silver solder, lead and aluminum. After 96 hr at 200 C (392 F) in contact with brass, lead or solder, the viscosity of the 1,000 centistoke silicone fluid decreases 10 to 15 percent below that of the control. Viscosity is about 15 percent above that of the control sample after 96 hr at 200 C in contact with iron or aluminum. At that temperature, silver solder causes an increase of 70 percent in viscosity.

These silicone fluids have good resistance to chlorine, nitric acid, sodium chloride, sulfur dioxide, and sulfuric acid up to a 30 percent concentration.

To a certain extent, however, solubility varies with viscosity grade. Fluids having a room temperature viscosity of 10 centistokes or less are more completely soluble in solvents with which the higher members of the series are only partially miscible. Presence of water in the solvent greatly reduces the solubility of any of the silicone fluids.

WATER REPELLENCY. All of the silicone fluids in this group are insoluble in water. Because of their low surface tension, about 20 dynes/cm, they readily wet surfaces of glass and ceramics, making them highly water repellent. As indicated by measurement of the contact angle between a drop of water and a silicone treated glass surface, silicone fluids are at least as water repellent as any hydrophobic material. The contact angle for paraffin, which is commonly accepted as being the most water repellent material, is 105-106 deg. The contact angle between a drop of water and a glass surface properly treated with a silicone fluid is between 90 and 110 deg. (L. A. Spitze and D. O. Richards, *J. Applied Physics*, 18, 904, 1947).

Because of their water repellency, heat stability and good dielectric properties, the fluids are used to maintain the high surface resistivity of glass or ceramic insulator bodies. Silicone treated insulator bodies shown in Fig. 6 have a surface resistivity in the order of 1.5×10^{12} ohms. Even after 8 days of immersion in sea water, surface resistivity decreases only slightly to about 1.8×10^{11} ohms. The silicone surface also has a low power factor.

Electrical Properties

Neither frequency nor temperature changes have any pronounced effect on the power factors or dielectric contric constants of the silicone fluids. Temperatures from —17 to 83 C have practically no effect on power factor and very little effect on dielectric constant.

The dielectric constants of these fluids are shown in Fig. 7. Dielectric strength of the fluids at 10 mils is in the order of 250-300 volts per mil. At 100 mils dielectric strength is in the range of 500 volts per mil. Volume resistivity for the 500 centistoke fluid is about 10^{14} ohm centimeters and remains relatively constant at temperatures up to 200 C (392 F). Power factors are low, falling within the range of 0.0001 at 10^2 to 0.0006 at 10^5 cycles.

Low dissipation factors at elevated temperatures or at high frequencies, inertness to moisture, oxidation resistance and heat stability make the silicone fluids useful as liquid dielectrics, in capacitors and transformers.

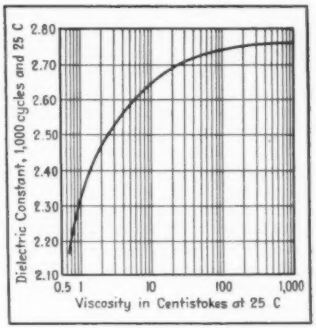


Fig. 7—Dielectric constants of silicone (DC 200) fluids. Physical and chemical properties fit them as liquid dielectrics.

Compressibility

The compressibility of the silicone fluids is high compared with light mineral oils, petroleum hydraulic fluids and glycerine. Actual measurements made by one group of investigators indicate that the compressibility of 0.65 centistoke fluid is in the order of 7½ percent under a pressure of 10,000 psi and about 12½ percent under a pressure of 25,000 psi. Compressibility decreases with increasing viscosity grade, reaching a value of about 5½ percent for 1,000 centistoke fluid under 10,000 psi and about 9½ percent under 25,000 psi pressure.

Lubricants

The higher viscosity silicone fluids meet the requirements of a good lubricant more completely than any organic oils. Research has established the fact that where rolling friction is involved silicone fluids have good lu-

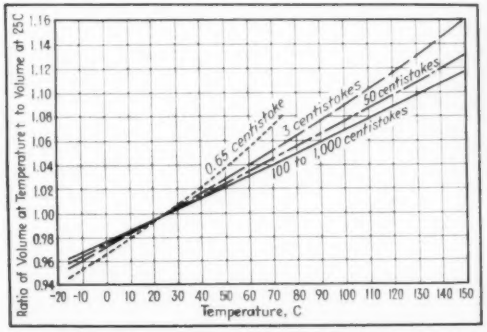


Fig. 5—Effect of temperature on volume of silicone (DC 200) fluids. Volume at any temperature is calculated from curves.

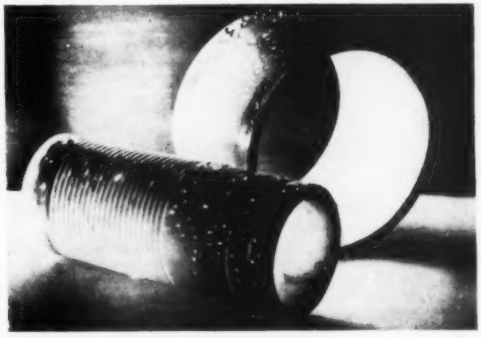


Fig. 6—Metal banded glass coil forms, waterproofed by silicone fluid, retain surface resistance indefinitely in moist atmosphere.

bricity, as indicated by slight wear between steel rolled against steel even where unit loads are high. Where sliding friction is involved, and both surfaces are ferrous, silicone fluids have limited load-carrying capacity and permit excessive wear.

Tests indicate that silicone fluids are good lubricants in either sliding or rolling friction between plain or chrome plated high carbon steel and aluminum, copper, copper-lead, brass, bronze or tin base babbitt. At elevated temperatures, silicone fluids are generally superior to petroleum oils as lubricants for these metal combinations.

Evaluation of 100 centistoke silicone fluid, as a lubricant for steel against brass under loads in the range of 6,000 to 28,000 psi, has been carried out at various temperatures. At temperatures between 25 and 100 C (77 to 212 F) these fluids have a lubricity that compares favorably to that of non-additive petroleum oils of comparable viscosity. At temperatures above 100 C the silicone fluids have a greater load-carrying capacity than comparable petroleum oils and greater lubricity as indicated by reduced wear of the bearing surfaces.

The load-carrying capacity of silicone fluids can be further increased if the bearings are run-in slowly or if the bearings are first immersed in the silicone fluid and heated for 24 hr at 150 to 200 C (300 to 400 F). Such conditioning develops a very thin silicone "lacquer" surface which has excellent load carrying capacity and durability.

Studies of the performance of silicone fluids in unilaterally loaded journal bearings indicate that 50 centistoke silicone fluid has about 3 times the load-carrying capacity of a non-additive petroleum oil in a chrome plated steel journal rotating against a bronze bearing at 63 C (145 F). In the same type of journal bearing this fluid gave satisfactory performance for long periods of time at 150 to 190 C (300 to 375 F).

The silicone fluids are among the best lubricants for natural and synthetic rubber and for polystyrene, phenolics and most other plastics. They are effective lubricants for fiber gears and plastic or rubber bearings, and for rubber or plastic insulated cable that must be drawn through metal harnesses or conduit.

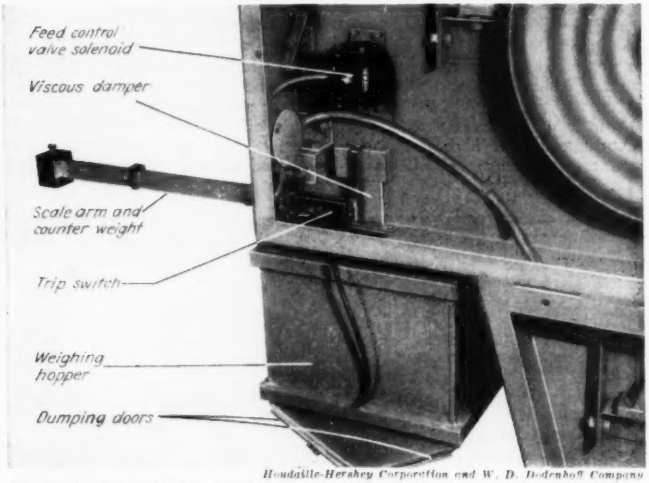
Damping Media

The torsional vibration damper developed by the Houde Engineering Division of Houdaille-Hershey Corporation demonstrates the usefulness of high viscosity silicone fluids as damping media. This device consists of an inner flywheel and a hollow disk casing attached to the end of the crankshaft. The inner flywheel is separated from the outer casing by a very thin film of a high viscosity silicone fluid. Because of the high viscosity of the fluid, the inner flywheel or inertia mass rotates uniformly at engine speeds. When critical speeds that cause torsional vibration are reached, however, the flywheel tends to continue to rotate at a constant speed. Hence the torsional vibrations are damped by the drag of the viscous film between the casing and the inner flywheel. The device damps both major and minor critical orders of vibration and requires no tuning. It is in general use on internal combustion engines ranging in size from automobile engines to locomotive diesels.

A similar device protects a delicate automatic mechanism (Fig. 8) for weighing fibers. Excessive vibration is eliminated by the use of a viscous damper which at the time of tripping almost instantly brakes the movement and permits the balance to return immediately to a static position.

In shock absorbers, silicone fluids offer greater permanents and uniformity of action. Silicone fluids are now being used in a number of small shock absorbers that must give constant performance over a wide range of temperatures. In overload relays, circuit breakers and thermostatic controls, silicone fluids are used as dashpot liquids.

The pointers of automobile and aircraft instruments and gages are now damped with these fluids to prevent fluttering and to permit more accurate readings. A minute amount of very high viscosity fluid is applied to the bearings of the pointer spindles in such instruments as gas gages, ammeters, speedometers and tachometers.



Houdaille-Hershey Corporation and W. D. Dodenhoff Company

Fig. 8—Feeder mechanism for all types of fibers incorporates an automatic weighing device that depends on the action of a silicone fluid damper. Aluminum weighing mechanism is mounted on spring steel straps and controlled by solenoid switches so that a battery of "fiber meters" will deliver accurately proportioned quantities of fiber. Excessive vibration is prevented by the viscous damper, which operates as soon as the weighing mechanism trips, permitting the balance to return to its static position.

Hydraulic Fluids

In fluid pressure operated devices silicone fluids are exceptionally resistant to shear breakdown and can therefore be used efficiently in more compact hydraulic systems designed to operate under higher pressures. In instruments and gages, the fluids are now being used because they transmit pressure at a more nearly constant rate over a wide temperature span. In a magnetic fluid clutch announced recently by the National Bureau of Standards, a mixture of powdered iron and silicone fluid is being tested as a coupling medium between the driving ring and the driven plates. By varying the strength of the magnetic field, torque can be varied from a minimum which is determined by the viscous drag of the fluid and iron mixture, up to the locking point.

The methyl silicone fluids are also produced in viscosities ranging from 30,000 to 1,000,000 centistokes at 25 C. The properties of these high viscosity members of the series are similar to those in the 100 to 1,000 centistoke range.

"Give us the tools . . ."

McGraw-Hill Surveys BUSINESS NEEDS

If it can get the money American industry in 1949 will go full steam ahead with a vitally-needed program of improving its facilities. This program since V-J Day has kept business expanding and has made belated headway in modernizing industry.

Furthermore, if it can get the money American industry will carry on for the next five years with its unprecedented program of expenditure for new plant and equipment. Plans already made call for spending about $55 billion.

These are findings of the McGraw-Hill national survey of "Business' Needs for New Plants and Equipment." Major results of the survey, which have been rechecked since election day, are summarized on the following page. They report what American industry is now planning to spend for new plant and equipment. *They do not and cannot show what will be done if the plans are hamstrung by political action.*

In 1949, the survey shows, American industry plans to spend $14.1 billion for new plants and equipment. That is only about 5% less than was actually spent in 1948.

If these plans are carried out, actual capital expenditures this year may be somewhat larger than they were in 1948. That is because expenditures usually prove to be larger than planned.

Fulfillment of American industry's plans for investment in new plant and equipment this year would no doubt mean a continuation of general prosperity. The record shows that when capital expenditures are high general business thrives.

Even more remarkable than the 1949 prospect is the fact that:

Industry already plans to spend $41 billion in the years 1950-53 to improve its plants and equipment.

Plans tend to taper off, of course, as they are pushed further into the uncertain future, five years from now. But the striking fact is that plans for expenditures so far ahead are as great as they are. They show American industry's need for tremendous improvements in its plants and equipment.

Again, let there be no mistake. These survey findings are not a five-year forecast. They report what leading corporations now are planning to do – *if they can get the money.*

But – won't industry be top-heavy with plants and equipment if it carries through any such program?

The answer is clearly – "No".

Here are some of the reasons why not that were disclosed by the McGraw-Hill survey:

First, manufacturing industries are shifting emphasis from expansion to improving efficiency.

They have increased their total capacity 56% since 1939. Their expenditures in 1948 went almost 50-50 for expansion and improvement. But in the next five years they plan to spend three-quarters of their funds to replace and modernize facilities, only one-quarter for expansion.

Second, the prospective rate of expenditure for new plant and equipment is relatively low.

Planned expenditures for new plant and equipment in 1949 represent about 7.5% of the present value of all plant and equipment. That rate of capital expenditure is no higher than the rate during previous periods of prosperity. And industry must overcome years of starvation for new equipment, caused first by the depression of the 30's, then by diversion to war production.

Third, industry is following an extremely cautious policy in buying new equipment.

Three out of four companies report that they will not buy equipment unless it will pay for itself within five years. And a third of the companies report that they expect new equipment to pay for itself within three years. The reason most frequently given for such expectations was that all the money available can be spent on equipment which does pay for itself quickly.

The program of capital expenditure planned by American industry is one of the greatest bargains ever offered to the American people.

To pay for itself in a few years, as equipment must if most companies are to consider buying it, that equipment

continued on next page

WHAT THE SURVEY SHOWS

● HERE ARE THE MAJOR FINDINGS of McGraw-Hill's survey of "Business' Needs for New Plants and Equipment". Rechecked since Election Day, results show what industry is now *planning* to spend for new plants and equipment. They do not forecast what will actually be spent. The survey shows:

1. Industry now plans to spend $14.1 billion in 1949 – and almost $41 billion in the four years beyond, 1950-53.
2. Manufacturing industries alone plan to spend $7.2 billion in 1949. This is 7.5% of the estimated value – $96 billion – of all manufacturing facilities.
3. Manufacturers estimate conservatively that it would cost $136 billion to completely replace their facilities with the most modern plants and equipment available.
4. Postwar expansion is virtually complete in most manufacturing lines. Major exceptions: steel and petroleum refining.
5. Expansion programs of railroads, utilities, and oil companies still have two to five years to run.
6. Manufacturing industries have increased their capacity 56% since 1939. But expansion is slowing down. Increase planned in the next five years is only 13%.
7. Efficiency is emphasized more and more in planning new facilities. Manufacturers plan to devote almost three-quarters of their funds to replace and modernize. In 1948, 58% went to increase efficiency this way.
8. Equipment should pay for itself in five years or less, say three out of four manufacturing companies. New buildings, say 77% of them, should pay out in 15 years or less.
9. Profits and reserves are counted on to pay for new buildings and equipment by three out of four manufacturing companies. Some 15% expect to borrow, only 9% plan to sell stock. However, 20% would like to sell stock, only 4% want to borrow.
10. More liberal depreciation allowances for income tax purposes would prompt almost two-thirds of the companies to speed their purchase of new plants and equipment.

● A copy of a complete report on "Business' Needs for New Plants and Equipment" may be obtained by writing me at McGraw-Hill Publishing Co., 330 West 42nd St., New York 18, N. Y.

must promise to produce much better products or make great savings in labor and material. The savings go first to the companies buying the equipment but, as they always have, they soon spread to everyone in the form of better products at lower costs.

Where does industry expect to get the money to buy this bargain for the American people?

Most of the companies covered by the McGraw-Hill survey (76% of the total) count on their own resources – largely profits – to pay for new plant and equipment. About 15% of them expect to borrow money, although only 4% like the idea of getting saddled with fixed debt. Only 9% of the companies expect to sell stock to investors, although twice that many report they wish they could.

What are the chances that business can get the money?

The survey provides no answer to that question. No survey can.

The answer will come from Washington – in what Congress does about taxes on profits and taxes on the millions of Americans who might invest a part of their income in industry's new plants and equipment.

The answer will be found also in the energy and skill shown by investment bankers, particularly in mobilizing the resources of the millions of Americans whose incomes have increased enough since 1940 to make them potential direct investors in industry.

Still another important part of the answer will be given by labor leaders. About half the companies surveyed by McGraw-Hill are holding back on new construction – primarily because of high costs. What organized labor does about wages and productivity can swell or shrink that percentage.

The McGraw-Hill survey leaves no doubt that American industry is fulfilling its responsibility. It is planning the capital improvements needed to make the nation secure, prosperous, and progressive.

But business today lacks confidence and badly needs added incentives. Proper taxation and increased depreciation allowances are vital if we are to open the capital markets to finance industry.

What will happen now depends in large part on what is done in Washington. In his State of the Union message, the President said that "business should plan for steady, vigorous expansion." But in his budget message he proposed new taxes which would divert a substantial share of the money industry is using for expansion and improvement. Moreover, he said nothing about the vital issues now freezing the capital markets.

It is not possible to have it both ways. Fulfillment of the President's tax program means cutting industry's program for new and better equipment. It means slowing down industrial progress. It means delaying the advance toward much higher standards of living tomorrow in order to have a little more government spending today.

I urge you to see that your Representative and your Senator have all the facts on industry's needs for new plant and equipment. What they do to this program will have a decisive bearing on the nation's security and welfare.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Company, Inc.

This is the fourth editorial of a special series on industry's needs for new plants and equipment – and what these needs mean to all Americans.

Hydraulic Standards For Industrial Equipment

Compiled by the Joint Industry Conference comprising the following cooperative groups: Automotive Joint Industry Conference, Hydraulic Equipment Manufacturers, Hydraulic Press Manufacturers, National Machine Tool Builders' Association, Resistance Welder Manufacturers Association, Tubing and Fitting Manufacturers.

SECTION			PAGE
H0	General		115
H1	Diagrams		115
	Circuit Diagrams	Par. H1.1	
	Standard Symbols	H1.3	
	Standard Fluid Legend Code	H1.4	
	Diagram Size	H1.5	
H2	Hydraulic Controls		118
	Definition of Controls	H2.1	
	Protection	H2.3	
	Controls Circuit	H2.4	
	Enclosures and Compartments	H2.5	
	Mounting	H2.6	
	Relief Valve Springs	H2.8	
H3	Pumps		119
	Mounting of Pumps	H3.3	
	Pump Nameplates	H3.5	
H4	Piping, Fittings and Fluid Passages		120
	Identification of Piping	H4.4	
H5	Oil Reservoirs		121
	Heat Exchangers	H5.5	
H6	Valves, Accessories and Devices		122
	Filters	H6.1	
	Sealing Devices	H6.2	
	Cylinders and Pistons	H6.3	
	Valves	H6.4	
	Accumulators	H6.5	
H7	Safety		122

Glossary of Terms Used in the Hydraulic Specifications

All Diagrams: Size of interconnecting lines and characteristics of electrical equipment shall also be shown. Data, or text, or both shall describe the function for each phase of the complete cycle.

Automatic Controls: Those actuated in response to the cycle of the equipment.

Back Connected: Where piping connections are on normally exposed surfaces of hydraulic components.

Channel: A fluid passage the length of which is large with respect to its cross-section dimension.

Clarifier: A device for the removal of deleterious solids and which assists in maintaining the chemical stability of hydraulic fluid.

Compartment: A space within the base, frame, or column of the equipment.

Cylinder: A linear motion device in which the thrust or force is proportional to the effective cross sectional area and to the pressure drop.

Cylinder, Single Acting: A cylinder in which the fluid force can be applied in only one direction.
Plunger Type: A cylinder in which the internal element is of a single diameter, and upon which the seal applied is of the contracting type.
Piston Type: A cylinder in which the internal element is of one

or more diameters, and the seal is of the expanding type.

Cylinder, Double Acting: A cylinder in which fluid force can be applied in either direction.
Single End Rod: A cylinder with a rod extending from one end.
Double End Rod: A cylinder with two rods, one extending from each end.

Enclosure: A housing for hydraulic apparatus.

Filter: A device for the removal of solids from a fluid wherein the resistance to motion of such solids is in a tortuous path.

Front Connected: Where piping connections are normally on exposed surfaces of hydraulic components.

Hydraulic Panel:
1. Hydraulic Mounting Panel
A plate on which may be mounted a number of hydraulic components.
2. Hydraulic Control Panel
A grouping of hydraulic control units mounted to form one assembly on a plate, or in a casting, and having a single mounting surface.

Line: A tube, pipe, or hose which acts as a conductor of hydraulic fluid.

Line, Drain: A line returning leakage oil independently to the reservoir or vented manifold. If returning to reservoir, it shall have reservoir symbol; and if to a vented manifold, it shall have a vented manifold symbol, a single line inverted T.

Line, Exhaust: A return line which carries power or control actuating fluid back to the reservoir.

Line, Joining: A line which crosses or connects with another line on a diagram and which also connects hydraulically in construction. The junction of the lines shall be indicated by a dot which must be at least three times the width of the line.

Line, Passing: A line which crosses another line on a diagram, but which does not connect hydraulically in construction. Line on a diagram to have no swell at crossing.

Line, Pilot: A line which acts as a conductor of control actuating fluid.

Line, Working: A line which acts as a conductor of power actuating fluid.

Manual Controls: Those actuated by the operator, regardless of means.

Mass Production: For a model run, or an indefinite period of time.

Motors and Cylinders: Devices for converting hydraulic energy into mechanical energy.

Motor Oscillating: A motor producing a maximum angular rotative movement of less than 360 deg in either direction.

Motor, Rotary: A motor producing rotary motion having torque output proportional to the displacement per revolution and to the pressure drop between intake and exhaust ports.

Motor, Rotary, Fixed Displacement: A rotary motor in which the displacement per revolution is not adjustable.

Motor, Rotary, Variable Displacement: A rotary motor in which the displacement per revolution is adjustable.

Passage: A machined or cored connection which lies within or passes through a hydraulic component, and which acts as a conductor of hydraulic fluid.

Phase of Cycle:
0. Neutral
1. Rapid Advance
2. Feed or pressure stroke (Forward and Return)
3. Dwell
4. Rapid Return
Rapid Advance: The approach of the tools or workpiece to the feed position.
Feed: The portion of the cycle where work is performed on the work-piece.
Dwell: The portion of the cycle where the feed rates or pressure stroke is stopped.
Rapid Return: The return of the tools or work-piece to the cycle starting position.

Port: An opening at a surface of a component; e.g., terminus of a passage. May be internal or external.

Port, Valve: A controllable opening between passages; i.e., one which can be closed, opened, or modulated.

Positive Position Stop: A structural member which definitely limits the working motion at a desired position.

Positive Safety Stop: A fixed structural member which confines maximum travel within the design limits of the machine or equipment.

Pressure Time Diagram: A graphical presentation of pressure in pounds per square inch plotted against time for a complete cycle of the equipment.

Pump: Device for converting mechanical energy into hydraulic energy.

Fixed Displacement: A pump which delivers a relatively constant volume of fluid per cycle.

Variable displacement: A pump in which the volume per cycle can be varied.

Restriction: A device which produces a deliberate pressure drop or resistance in a line or passage by means of a reduced cross-sectional area.
Choke: A restriction, the length of which is relatively large with respect to its cross-section dimensions.
Orifice: A restriction, the length of which is relatively small with respect to its cross-section dimensions.

Restriction Choke (Fixed Viscous): A non-adjustable resistor in which the pressure drop rate of flow is not entirely independent of viscosity.

Restriction Orifice (Fixed Non-Viscous): A non-adjustable resistor in which the pressure drop or rate of flow is relatively independent of viscosity.

Schematic Diagram: A drawing or drawings showing the functional construction of all valves, controls, and actuating mechanisms.

Sealing Device: A part or assembly of parts used to prevent leakage between two or more other parts.

Strainer: A device for the removal of solids from a fluid wherein the resistance to motion of such solids is in a straight line.

Sub-Plate (Back Plate): An auxiliary mounting for a hydraulic component to which piping connections are mounted.

Surge: A transient rise of hydraulic pressure in the circuit.

Symbolic Diagram: A drawing or drawings showing by means of approved standard symbols each and every piece of hydraulic apparatus including all interconnecting lines.

Trip: A mechanical element for the actuation of a position control.

Unit Production: One piece per set-up.

H0 General

H0.1 (A) The purpose of these Standards is to provide detailed specifications for the application of hydraulics to industrial equipment which will promote safety of personnel, uninterrupted production, long life of the machine, equipment or tool, and will not limit or inhibit advancement in the art of hydraulics.

(B) Where new developments in hydraulics will perform in a manner equal to these specifications, they will be considered as equivalent.

H0.2 These standards are proposed to cover hydraulic equipment in general applications. Any exceptions to these Standards will be as agreed between supplier and purchaser.

H0.3 The purchaser shall specify such additional details as are needed to meet unusual operating conditions.

H0.4 (A) The builder shall submit necessary performance specifications on hydraulic equipment, including symbolic or schematic diagram, for purchaser's approval. Final diagrams and text shall conform to the hydraulic equipment shipped.

(B) Part numbers shall be provided for all types of hydraulic equipment. Seal manufacturer's catalog number shall also be provided where sealing devices are commercially available.

H0.5 All hydraulic equipment shall be installed and used in accordance with the recommendations of the manufacturers thereof.

H0.6 Hydraulic and lubricating systems shall be separated or in accordance with the following provisions:

(A) In no case shall hydraulic fluid be used to lubricate ways, slides, or any exposed surface or mechanism.

(B) When separation is impracticable, combinations utilizing lubricating systems are permissible, only if unit pressure is low, operation is infrequent or of an auxiliary nature.

(C) When systems are combined, means shall be provided to remove contamination.

(D) Whenever hydraulic and lubricating systems are combined, complete information shall be given on the hydraulic system diagram.

H0.7 (A) Under normal conditions of continuous operation the pump inlet temperature of the fluid shall not exceed 130 F.

(B) In no case shall a sensitive temperature measuring device placed anywhere in the hydraulic circuit indicate a local temperature above 250 F. This paragraph applies to petroleum base fluids only. For fluids other than petroleum base fluids operating temperatures shall be as agreed upon between supplier and purchaser.

H0.8 All industrial equipment at the completion of assembly and before shipment shall be given complete performance tests to determine conformity with equipment specifications. There shall be no evidence of external leakage.

H0.9 A pressure time diagram taken under operating conditions including data concerning maximum rate of pressure rise, maximum surge pressure and surge frequency shall be furnished when specified on purchase order.

H0.10 Hydraulic Equipment shall be of proven engineering design, fabricated of material of accepted quality and with workman-like finish; and must be capable of performing efficient, reliable service in the installation for which they are provided.

H1 – Diagrams

H1.1 – Circuit Diagrams

H1.1.1 (A) Symbolic Diagram—A drawing or drawings showing by means of approved standard symbols each and every piece of hydraulic apparatus, including all interconnecting lines.

(B) Schematic Diagram—A drawing or drawings showing the functional construction of all valves, controls, and actuating mechanisms, including all interconnecting lines.

H1.1.2 Symbolic Diagrams

(A) Symbolic diagrams shall be furnished with industrial equipment. (Schematic diagram acceptable.)

(B) A copy of the diagram shall be firmly attached to the inside cover of the hydraulic control enclosure or hydraulic diagram enclosure, either by adhesive material or by permanent data pocket or clip.

H1.1.3 Schematic Diagrams

(A) When requested on purchase order, a schematic diagram shall be supplied.

(B) When requested on purchase order, a schematic diagram shall show and describe the flow paths for each phase of each complete cycle.

(C) When requested on purchase order, a schematic diagram shall show in color only those portions of the circuit which are functioning at each single phase of the cycle. (See H1.4)

H1.1.4 All Diagrams

(A) The descriptive text shall explain the function of all components of the circuit and the sequence of the operations. Either the diagram or descriptive text shall include, in addition to the sequence of operations and the characteristics of any electrical equipment used, the following:

1. All hydraulic equipment shall be identified. When possible, catalog number and manufacturer's name shall be shown.
2. Recommended size of piping.
3. Diameters of pistons and rods, length of stroke, and estimated required force of cylinders when other than maximum pressure is applied.
4. Time of cycle, when pertinent (for example, time range of cycle exclusive of loading).
5. Operating pressures.
6. Horsepower and rpm of each pump drive.
7. Pump speed and delivery in gpm.
8. Reservoir capacity.
9. Recommended oil viscosity range.
10. Displacement, speed range, and torque rating of each hydraulic motor.
11. Data, or text, or both shall show operations performed and characteristics of any actuating electrical equipment used.

(B) The related text and the diagram shall be shown on the same or facing pages.

(C) All diagrams shall be marked with serial number or with the purchaser's order number of that equipment, or, if none, with some other symbol which will identify the particular apparatus to which the diagram applies.

(D) Requested number of copies of all diagrams required and texts shall be forwarded by mail or in person to an individual delegated by the purchaser not later than the date on which the shipment is made.

H1.3 Standard Symbols

Introduction.

Standard Symbols indicate the nature and function of component parts in the circuit.

Symbolic symbols show the function. Supplementary symbols show the method of operation, such as manual, electrical, hydraulic, etc. Function and method of operation are indicated by combining basic and supplementary symbols.

The symbols may be adapted to any type of hydraulic system. They may be used equally well for each piece of hydraulic apparatus in basic diagram as well as for showing flow paths in schematic diagrams.

The Standard Symbols are shown on this and the following two pages. On page 118 some, but not all, combinations of standard symbols are given.

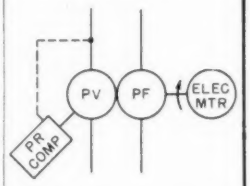
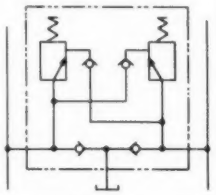
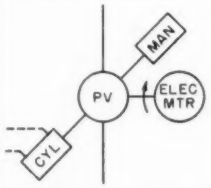
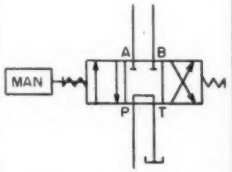
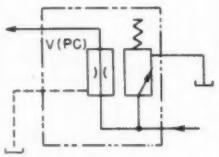
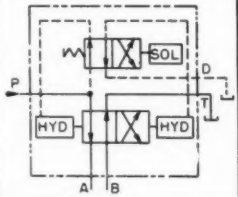
STANDARD SYMBOLS

Shall be in accordance with the following recommendations:
Basic symbols can be combined in any form desired. No attempt is made to show all combinations.

LINES		Manifold, vented		Motor, rotary, variable displacement	MV
Line, working		Plug or plugged connection	×	Motor, oscillating	MO
Line, pilot (L>20W)		Testing station (gage connection)	T S	Cylinder, single acting, plunger type	
Line, drain (L<5W)		Power take-off	P T O	Cylinder, single acting, piston type	
Line, flexible		Restriction, choke, fixed viscous		Cylinder, double acting, single end rod	
Connector (Dot to be 3 x width of associated line)	•	Restriction, orifice, fixed non-viscous		Cylinder, double acting, double end rod	
Direction of flow		**PUMPS**		**MISCELLANEOUS UNITS**	
Line, passing		Pump, single, fixed displacement	PF	Motor, drive, electric	ELEC MTR
Line, joining (Tee cross etc.) (Dot to be 3 x W)		Pump, single, variable displacement	PV	Heat exchanger	HE
Reservoir (fluid tank)		**MOTORS AND CYLINDERS**		Intensifier	INT
Line, to reservoir above fluid level / below fluid level		Motor, rotary, fixed displacement	MF	Accumulator	ACC

Filter	FILT	Valve, maximum pressure		Control, compensator pressure	PR COMP
Strainer	STRN	Valve, relief remotely operated		Control, compensator temperature	TEMP COMP
Pressure switch	PR SW	Valve, sequence directly operated		Control, cylinder	CYL
Pressure gage		Valve, pressure reducing		Control, detent	DET
Spring		Valve, flow control, pressure compensated viscous	V (PC)	Control, manual	MAN
Shaft, rotating		Valve, flow control, pressure compensated non-viscous	V (PC)	Control, mechanical	MECH
Component enclosure		Valve, shut off 2 position 2 connection		Control, motor electric	ELEC MTR
VALVE		Valve, directional 2 position 3 connection		Control, motor hydraulic	HYD MTR
Valve, check		Valve, directional 2 position 4 connection		Control, pilot hydraulic	HYD
Valve, restriction, choke variable viscous	V	Valve, directional 3 position 4 connection open center		Control, pilot, air	AIR
Valve, restriction, orifice, variable non-viscous	V	Valve, directional 3 position 4 connection closed center		Control, servo	SERVO
Valve, basic symbol (insert model No. for special valves)		**METHODS OF OPERATION**		Control, solenoid	SOL
Method of indicating internal flow		Control, basic symbol		Control, solenoid, hyd. pilot operated	SOL HYD
VALVE EXAMPLES		Control, centrifugal	CENT	Control, thermal	THERM
Valve, manual shut off		Control, compensator	COMP	Control, pilot hyd. differential area	HYD DIFF S

EXAMPLES OF COMBINATIONS

Pump, double—with electric motor One fixed displacement One variable displacement with pressure compensator		Valve, replenishing unit	
Pump, single—with electric motor Variable displacement Hand wheel and cylinder control		Valve, 4 way Three position—spring centered manual control P→T, cyl. port blocked in center position (Note: Symbol shown in center position)	
Valve, flow control and maximum pressure with compensator		Valve, 4 way 2 position—spring offset solenoid control pilot operated	

H1.4.1 Standard Color Code

Pressure	Red
Return	Blue
Trapped Oil, or Restricted Return	Yellow
Intake and Drain	Green

H1.4.2 Single Color Code

Symbolic cross hatching can be used to identify hydraulic function. Where areas will permit ready identification, substitution of cross hatching for color code will be in agreement with purchaser.

Note: Standard symbols will be worked out and published at the earliest possible date.

H1.5 – Diagram Size

H1.5.1 All diagrams shall be on 8½ in. x 11 in. file size sheets, or in multiples thereof, if folded. The diagram shall be of such size as to clearly disclose all system components.

H2 – Hydraulic Controls

H2.1 – Definition of Controls

(A) Manual controls are those actuated by the operator, regardless of means. (B) Automatic controls are those actuated in response to the cycle of the equipment.

H2.3 – Protection

H2.3.1 Over-pressure protection shall be provided on the discharge side of all pumps. The adjustments on the pressure control units shall be accessible. Provision shall be made to permit locking enclosure or compartment in which pressure control unit is mounted, or protective locking type adjustments shall be provided to prevent tampering.

H2.3.2 All pressure controls shall be so constructed as not to be adjustable outside nominal working ranges, and shall be marked to indicate nominal minimum and maximum pressures.

H2.3.3 Where there is more than one pump on the equipment and possible damage may be caused by the stoppage of any one pump, interlocks shall be provided so that the stoppage of one pump in the circuit will not endanger or damage the equipment. Where the starting of the pump in an improper sequence can result in damage, interlocks shall be provided to insure the starting of all pumps in proper sequence.

H2.3.4 All necessary valves for removal of any pump while other pumps are still in operation shall be provided.

H2.3.5 Where pumps are operating in series, pressure protection shall be placed between pumps in series in order to protect any pump from carrying the entire load. (This will not apply to centrifugal pumps in series.) All conductors between pumps shall be of adequate strength for the intended pressure.

H2.3.6 Where loss of working pressure on discharge side of pump or pumps may result in damage to equipment, loss of accuracy, or danger of injury to personnel, means shall be provided to prevent operation under those conditions. When lubricating pumps are used as set forth in Paragraph H0.6 (B) the same conditions shall prevail.

H2.4 – Controls – Circuit

H2.4.1 When shifting from rapid traverse to feed, the starting position of the feed rate shall be maintained consistent with the type of service intended.

H2.4.2 Hydraulic circuits shall be so designed as to minimize the generation of heat and to conserve power.

H2.4.4 In each electrically controlled circuit, in case of solenoid failure, means shall be provided to prevent damage to equipment, accuracy loss, danger to personnel.

H2.4.5 Neutral valve positioning controls shall be independent of and unaffected by adjustment of other controls.

H2.4.6 Feed and cycle limiting devices on mass production equipment where feed is pre-set shall be adjustable and so designed that the feed distance can be set and sealed, (except where adjustment is necessary to compensate for tool wear).

H2.4.7 (A) Positive Position stops shall be so designed that the dwell time will not be affected when positive position stops are reset.

(B) Positive safety stops for machine slides shall be adjustable, but shall have provision for replacement.

H2.4.8 On industrial equipment operated at elevated temperatures or with toxic materials, the circuits shall be so designed and located that they can be serviced while equipment is operating under these conditions.

H2.4.9 Hydraulic circuits shall be so designed, constructed and applied that unnecessary surge pressures are minimized at their source, and equipment be of adequate strength to withstand all operating and surge pressures.

H2.4.10 Hydraulic circuits shall be so designed as to prevent uncontrolled movement of the equipment operating devices in all phases of the equipment cycle, including the idling phase.

H2.4.11 Hydraulic feed circuits shall be so designed and applied as to maintain consistent feed rates irrespective of reverse force or intermittent loads.

H2.4.12 Circuits having two or more heads or slides shall provide means to insure all units operating in proper relation regardless of load variation.

H2.4.13 Hydraulic circuits in mass production equipment shall be so designed and applied that load variations, and changes in fluid temperature ranges if automatically controlled, shall not cause variations in the cycle time of more than plus or minus 3%, 5%, 10%, 15%, of the specified basic cycle provided voltage, frequency, and manual operations do not change. Purchaser shall advise the percentage of degree of accuracy required.

H2.5 – Enclosures and Compartments

H2.5.1 For the purpose of these Standards, an enclosure means a housing for hydraulic apparatus. A compartment means a space within the base, frame, or column of the equipment.

H2.5.2 Automatic controls that might be damaged by exposure to dirt or dust or stock moving equipment shall be adequately protected and readily accessible.

H2.5.4 Doors and other parts of compartments for automatic controls shall be sheet steel not less than 14 USS gage, or cast metal not less than $\frac{1}{4}$ in. thick. Compartments for automatic controls shall be completely isolated from coolant, cutting or lubricating oil, chips, and dirt. All automatic control devices shall be mounted in one enclosure where possible and advisable.

H2.5.6 All enclosures for control devices, where practicable, shall have hinged covers which swing horizontally, or self-supporting sliding covers, and shall be held closed with screws which require the use of a tool (wrench or screw driver) to remove.

H2.5.7 The arrangement of enclosures for mounting controls shall permit ample room for proper maintenance.

H2.6 – Mounting

H2.6.1 (A) All Controls: All controls shall be mounted so as to minimize the possibility of damage from floor trucks or other stock moving equipment. They shall be protected against falling objects and operator's accidental movements. No controls shall be placed in high heat areas or in locations subject to any harmful conditions.

(B) Manual Controls: All manual controls shall be mounted within reach of the operator when in his normal operating position. Operator shall not be required to reach past revolving spindles or moving tools to reach manual controls. (See Paragraph H7.1.2)

(C) Automatic Controls: Automatic controls shall be so located and protected as to prevent inadvertent operation.

H2.6.2 All hydraulic controls shall be mounted two feet or more above the bottom of the equipment providing such mounting will not impair the proper functioning of the circuit. This paragraph is written as a guide for all new machinery and equipment with the understanding that any deviation will be in accordance with Paragraph H0.2.

H2.6.3 Hydraulic control units shall be mounted in positions which provide complete accessibility to all units for maintenance without interfering with adjacent equipment.

H2.6.5 All industrial equipment shall incorporate an emergency stop control readily accessible from operator's normal position.

H2.6.6 Internal leakage must be drained to reservoir or vented manifold to prevent blocking of plunger type controls.

H3 – Pumps

H3.3 – Mounting of Pumps

H3.3.1 Pumps shall be mounted where they are readily accessible for maintenance and are adequately protected from damage.
Recommended Practice for New Design: Pumps shall not be mounted inside reservoir.

H3.3.3 When pumps and other apparatus are mounted inside the compartment or enclosure, sufficient space must be provided to assure complete accessibility to all units.

H3.3.4 Pump compartments must be clean and free of moisture and adequately vented to the exterior of the industrial equipment and all openings must be of sufficient

height above the floor or be protected to such an extent that dirt, chips, coolant, etc., cannot enter, especially at such times as floor is swept or washed, or the equipment is cleaned. Unless other compartments meet the requirements of the pump compartment, there shall be no openings of any kind between the pump compartment and any other compartment.

If piping is run into the pump compartment from another compartment not meeting the pump compartment requirements, adequate seals shall be provided.

H3.3.5 Direct coupled pumps must be properly aligned and securely mounted in such a manner as to assure alignment under normal operating conditions. When mounted inside column or base of equipment, foot mounted pumps and driving motors shall be mounted on a sub-base of adequate strength which can be easily removed for servicing. The coupling must have adequate capacity to transmit the power required.

H3.5 – Pump Nameplates

H3.5.1 The following information shall be permanently indicated on each hydraulic pump:

(A) Manufacturer's name and address.
(B) Manufacturer's identifying part number.
(C) Manufacturer's serial number if any.

A data sheet or catalog providing complete information on speed limits, pressure range, delivery, horsepower required, and viscosity range, shall be provided with the specifications.

H3.5.2 Whenever a pump is mounted so that its nameplate is not readily visible, a plate with duplicate information shall be provided where it can be readily seen. Such duplicate plate shall be marked "duplicate." The nameplate shall not be removed from the pump.

H3.5.3 The direction of rotation of each pump shall be clearly indicated on the pump where it can be readily seen.

H4 – Piping, Fittings, and Fluid Passages

(Piping includes all pipe, tubing, hose and fittings. Passages include all fluid conductors other than piping.)

H4.1.1 When requested by purchaser, a piping layout or photograph shall be furnished.

H4.1.3 Cross-sectional area of the piping shall be such that the flow capacity shall be sufficient on the suction side to prevent cavitation or starvation of the pump; and on the discharge side to prevent undue temperature rise or turbulence. Piping shall have adequate strength to withstand additional pressure, including surge pressure, within the safety limits of the entire circuit. A factor of safety of at least eight (8) over normal working pressure is suggested.

H4.1.4 (A) Unnecessary surges shall be minimized at their sources, and adequate protective devices shall be provided in piping circuits to protect piping and fittings against hydraulic impact.

(B) The strength of the piping shall be adequate to withstand the maximum rate of surge pressure rise and the maximum surge peak pressure at the frequency developed by the cycling of the equipment operation.

H4.1.5 Piping leads in working circuits between actuating devices and feed control devices shall be so constructed as to rigidly confine a minimum volume of fluid, the purpose being to maintain constant controlled motion and restrict the effect of varying forces.

H4.1.6 (A) Solderless piping connections shall be used.

(B) The performance of any type of fitting used shall equal or exceed the requirements of AN-F 47.

(C) When flared type fittings are used (which require a flaring tool), the angle of flare of tubing shall be 37 deg from the centerline 74 deg included angle, and flare dimensions shall be in accord with Army-Navy Design 10061.

(D) When flared type fittings are used, the construction of the tube end (i.e. tubing end of connector body, nut, and sleeve when used) shall conform to joint Army-Navy specification AN-F 366 for minimum performance requirements. Modifications may be used if performance conforms with the requirements of sentence (B).

(E) All Pipe Threads shall be Dryseal American (National) Standard Taper Pipe Threads (N.P.T.F.).
(This is to become mandatory within six (6) months after the hydraulic Standards for Industrial Equipment have been authorized for publication as approved Standards.)

(F) On installations in which fitting alignment is important, fittings with straight threads and which incorporate seals that seal with pressure may be used in place of pipe thread fittings.

Definition of Pressures

Low	0 to and including	200 psi.
Medium	Above 200 to and including	500 psi.
Medium High	Above 500 to and including	1,200 psi.
High	Above 1,200 to and including	3,000 psi.
Extra High	Above 3,000 psi.	

Tubing and Fittings

(See Attached Recommended Practices)

1. Tubing OD sizes shall increase in $\frac{1}{16}$ in increments from $\frac{1}{8}$ in. to and including $\frac{3}{8}$ in., and in increments of $\frac{1}{8}$ in. above $\frac{3}{8}$ in. dia up to and including 1 in. dia and in $\frac{1}{4}$ in. increments above 1 in. diameter.

2. S.A.E. 1010 dead soft, cold drawn seamless steel tubing or equivalent and steel fittings shall be used.

3. Copper tubing or copper alloy fittings are not permissible with petroleum base fluids.

4. Fittings with restricted or stepped-up passages are not recommended.

H4.1.7 All piping, piping fittings, oil passages, reservoirs, cored holes or drilled holes must be free of burrs, or foreign matter which might cause damage to any hydraulic unit or contamination of the hydraulic fluid. Sharp edges shall be removed whenever they adversely affect the flow of hydraulic fluid.

H4.1.8 Whenever practicable, each piping run must be integral and continuous from one piece of apparatus to another. Piping runs must be removable without dismantling equipment components and without bending tubing or springing it in a manner to damage it. All rigid piping must be securely supported at frequent intervals to avoid vibration or movement. Points of contact or support on the outside of the piping shall be so designed that they will not result in damage to the piping. Piping shall not be welded to supports.

H4.1.9 If high or extra high pressure piping above 1 in. is used, all connections shall be welded to steel flanges (all welded joints shall be stress relieved); each run shall be separate so that it can be removed by flanged connection using sealing devices that seal with pressure.

H4.2.4 All portions of piping circuits above 150 psi operating pressure subject to movements in which flexible hose is required, the flexible rubber hose shall be fabricated to a pressure safety factor of at least five (5) with respect to the circuit in which it is used. Below 150 psi operating pressure, the use of plastic tubing shall be permissible. Flexible hose and plastic flexible tubing shall have vertical connections and shall have sufficient slack to avoid sharp flexing and straining. Horizontal connections are acceptable only if tubing is adequately supported.

H4.2.5 Multiple controls shall be mounted on a single plate within one enclosure, whenever possible, to eliminate excessive piping.

H4.2.6 Piping shall not be placed where it will interfere with the adjustment, repair or replacement of control or units, and piping connections shall be readily accessible for maintenance.

H4.2.7 Hydraulic units provided with external drain connections shall be drained independently to reservoir or to a vented manifold.

H4.4 – Identification of Piping

H4.4.1 Piping runs shall be identified to correspond with diagram.

H4.4.2 When construction of equipment necessitates shipment or moving in sections, thorough precautions shall be taken to adequately protect piping runs, whether they be left in place on one of the equipment sections or whether they are removed and separately boxed for shipment. All male threads shall be sleeved, and all piping openings or female threads equipped with suitable closures.

H4.4.3 Piping shall be so arranged that pressures may be tested at accessible locations, preferably at built-in checking stations which shall be indicated on diagrams.

H5 – Oil Reservoirs

Separate or Integral with Machine

H5.1 A hydraulic fluid reservoir shall be designed, and constructed in such a manner as to prevent the entrance of any foreign matter, chips, coolant, lubricating or cutting oil, dirt, etc.

Fluid reservoirs should preferably be made separate and removable from equipment bases.

If cast, fluid reservoirs must be impregnated and sealed before assembling into equipment, with a sealer which is inert to hydraulic fluid. This must be tested by means of light petroleum solvent. If welded, welds must be tested with light petroleum solvent.

H5.1.1 The filler hole shall have a fine mesh screen, removable for cleaning and replacement, for straining the oil when filling, and shall be provided with a well fitted cap or cover permanently attached to the reservoir by some suitable means.

H5.1.2 A breather hole properly protected by an air cleaner shall be provided. The breather and filler must be separate and have sufficient capacity to permit rapid filling. The air cleaner must also be of sufficient capacity to maintain approximate atmospheric pressure at maximum circuit demands.

H5.2 The capacity of the fluid reservoir shall be sufficient to contain all of the fluid that will drain from the system back into the tank by gravity flow; maintain the fluid level within a reasonable working height during operating cycle; dissipate heat generated by normal operation of the equipment; allow air and foreign matter to separate out of the fluid.

H5.2.1 The reservoir shall be equipped with a flush mounted or protected fluid level indicator, preferably located near the filler cover. It shall be provided with markings to show high and low level with pump running and, where necessary, high level with pump stopped.

H5.3 Both the intake and return pipe shall be brought down below the minimum working fluid level so as not to cause cavitation or aeration.

H5.3.1 Suitable means shall be provided between the intake and return pipes to facilitate settling out of foreign matter in the fluid. The intake and return pipes shall not be located in a manner which will interfere with the efficient operation of the hydraulic system.

H5.4 Ample and accessible provisions shall be made for complete cleaning of the reservoir.

H5.4.1 A well protected, accessible means shall be provided to empty the reservoir without spillage.

H5.5 – Heat Exchangers

H5.6 The heat exchanger provided, if required, shall be of proper design, and its application shall be subject to approval by purchaser.

H5.6.1 It shall be the responsibility of the purchaser to advise supplier incorporating the heat exchanger in the equipment of any unusual temperature that would affect the equipment operation.

H5.6.2 The heat exchanger must be readily accessible for removal, in the event servicing or repair is necessary.

H5.7 The heat exchanger shall be so arranged that it is not possible to develop excessive pressures in the event the heat exchanger should become clogged.

H5.7.1 Heat exchangers using media which are deleterious to the system's hydraulic fluid shall not be installed in fluid reservoirs.

H5.8 The make, size, capacity, and requirements of heat exchangers (including supply pipe sizes) shall be agreed to by the purchaser, and shall be clearly indicated on hydraulic diagrams.

H5.9 Accessible arrangements shall be provided for checking inlet and outlet temperatures of the hydraulic fluid if circulating type heat exchangers are used.

H5.10 When heat exchangers are used, they shall be equipped with suitable automatic thermal controls.

H5.11 Heat exchangers shall not use copper or copper alloys in contact with uninhibited petroleum base fluids.

H6 – Valves, Accessories and Devices

H6.1 – Filters

H6.1.1 Means shall be provided for the continuous removal of deleterious materials from the hydraulic fluid which would be detrimental to the operation of the equipment.

H6.1.2 If the filter is of such design that they remove anti-foam agents or other additives, the type and design of the filter shall be agreed upon between the supplier and purchaser.

H6.1.3 Self-cleaning filters shall be automatically actuated.

H6.1.4 Filters shall be of such construction that the filter medium can be removed for cleaning without disturbing the piping. When available, suitable means shall be provided to indicate when filter should be cleaned.

H6.1.5 When suction strainers are provided, they shall be of ample size to strain more than double the intake capacity. Suitable means shall be provided to remove strainers without draining the reservoir.

H6.1.6 By-pass filter must be of sufficient capacity to filter the equivalent of all hydraulic fluid in the system within a period of eight (8) hours.

H6.2 – Sealing Devices

H6.2.1 All sealing devices must be of such materials that they will not be adversely affected by hydraulic fluid. Natural rubber shall not be used with petroleum products.

H6.2.3 Sealing devices on reciprocating or rotating shafts shall prevent all leakage, except that required for lubrication of such devices under all working conditions without damaging shafts.

H6.2.4 Holes in sealing glands shall be of such size as to prevent undue extrusion of the sealing material.

H6.3 – Cylinders And Pistons

H6.3.1 Cylinder bores having fitted pistons shall be finished in a manner consistent with the type of service intended and shall be free of porosity or other defects.

H6.3.2 Cylinders shall be located in alignment with work slides, and shall be such that no side or radial load shall occur on piston rod or ram, unless other suitable provisions are made to take such loads.

H6.3.3 Ends of cylinders shall utilize sealing devices that do not leak under any working conditions. Sealing devices that seal with pressure are recommended. All cylinder external sealing devices shall be readily accessible for servicing.

H6.3.4 Recommended Practice: Cylinders shall be separate, not cast integral with equipment, and in any event they shall be accessible for servicing.

H6.3.5 Pistons utilizing sealing devices which are not integral with the piston shall have automotive step-cut rings or equivalent in performance. Exceptions are permissible only for applications where no leakage (other than required for lubrication) can be tolerated.

H6.3.6 Piston rods shall be adequately protected by proper location, or by installation of cleaning and sealing devices. Where conditions require, material and hardness of piston rods shall be such as to prevent scoring.

H6.3.7 (A) When pistons are assembled to rod they shall be positively locked.

(B) Flow of fluid into non-rotating cylinders shall be at extreme tops of bores or other means provided to prevent entrapment of air.

H6.3.8 When necessary, cushions shall be provided on cylinder ends.

H6.3.9 Wherever possible, cylinders shall be so used in the circuit or circuits as to subject the solid head ends of cylinders to high pressure, and not to gland or rod ends.

H6.4 – Valves

H6.4.1 Adjustable valves shall be arranged so that wires and seals can be used after final adjustments and locking.

H6.4.2 Valves shall not be mounted in reservoirs except in self-contained units. Where valves, including solenoid operated valves, are mounted in reservoirs, they shall be kept above high fluid level, so maintenance and adjustments can be made without draining fluid, except where the function of the valve requires same to be below the oil level.

H6.4.3 Gasket mounted valves shall be used whenever possible so their removal and replacement can be made without breaking individual fluid lines. Gaskets of the pressure sealing type are recommended. Gasket mounted valves shall have locating pins.

H6.4.5 The operation of a valve shall not produce detrimental surges in the hydraulic system.

H6.4.6 On vertical or inclined slides or rams means shall be provided to prevent rapid drop when hydraulic power is shut-off.

H6.4.7 Solenoid operated valves shall be so designed, constructed, and installed as to eliminate destructive hammering.

H7 – Safety

H6.5 – Accumulators

H7.1.1 Flexible lines shall be restrained or confined if their failure might constitute a hazard to personnel.

H7.1.2 Operator shall not be required to reach past revolving spindles, moving tools, or moving machine or equipment elements to reach manual controls.

H7.1.3 Hydraulic circuits incorporating accumulators shall be so interlocked as to vent or isolate accumulator fluid pressure when power is shut off. On circuit applications where accumulator pressure is isolated full information shall be given on or near accumulator for proper servicing without injury to personnel.

NOTE: No changes can be made to these standards unless by mutual consent of the joint industry conference groups. Errors and omissions excepted.

Recommended Practice

Fittings (See H4.1.6 and H4.1.9)
Steel Tubing (See Below)

LOW PRESSURE

Steel tubing is recommended. Plastics and aluminum tubings are permissible.

Recommended minimum wall thickness for steel tubing:

Tubing diameter, in.	Tubing-minimum wall thickness, in.
To ¾, inclusive	0.035
⅞ to 1, inclusive	0.049
1¼ to 1½, inclusive	0.065

MEDIUM PRESSURE

Recommended minimum wall thickness for steel tubing:

Tubing diameter, in.	Tubing-minimum wall thickness, in.
To ¾, inclusive	0.035
⅞ to 1, inclusive	0.049
1¼ to 1½, inclusive	0.065

MEDIUM HIGH PRESSURE

Recommended minimum wall thickness for steel tubing:

Tubing diameter, in.	Tubing-minimum wall thickness, in.
To ¾, inclusive	0.035
⅞ to ¾, inclusive	0.049
⅞ to 1, inclusive	0.065
1¼ to 1½, inclusive	0.095

HIGH PRESSURE

Recommended minimum wall thickness for steel tubing:

Tubing diameter, in.	Tubing-minimum wall thickness, in.
To ¾, inclusive	0.060
⅞, inclusive	0.075
1, inclusive	0.095
1¼, inclusive	0.109
1½, inclusive	0.109
2, inclusive	0.120

Above 2 in. welded flange fittings or approved equal.

EXTRA HIGH PRESSURE

Specifications to be later developed.

Seamless Low Carbon Steel Tubing Annealed For Bending – Pressure Type

Following requirements are not mandatory under these standards.

1. Scope
This specification covers cold drawn and annealed seamless low carbon steel pressure tubing, for use as hydraulic lines.

2. Hydrostatic Test
Tubing supplied under this specification shall have been tested at not less than 1,000 lbs. hydrostatic pressure, or higher in case working conditions require.

3. Cleanliness
It is desired that the inside of tubing shall be bright, clean, and free from grease, drawing compounds, oxide, scale, carbon deposits, and any contamination that cannot be readily removed by cleaning with alkaline cleaners or benzine.

4. Corrosion Protection of Interior of Tubes
The inside of the tubing having open ends shall be protected by a coating of clean oil to protect the interior of the tubing against corrosion during shipment and normal storage periods.

The corrosion preventive oil used shall be such that after extending storage periods, it can readily be removed with an alkaline cleaning solution or with benzine (Stoddard Solvent).

5. Quality
Tubing shall be free from defects not in accordance with the best commercial practice.

6. Chemical Composition
Tubing shall conform to the following chemical analysis:

	Percent
Carbon	0.08-0.18
Manganese	0.30-0.60
Phosphorus	0.050-max.
Sulfur	0.055-max.

7. Physical Properties
Tubing shall conform to following physical requirements.

Tensile Strength, psi, max	55,000
Elongation in 2 in., min.	40 percent*

A three inch section cut from the tubing shall not crack or show any flaws when flattened between parallel plates to three times the wall thickness of the tube.

*For tubes with an OD of ⅜ in. and less and wall thickness of 0.035 in. and less, a minimum elongation of 30 percent is permitted.

A section of tube approximately 4 in. in length with the ends burred, shall withstand being expanded at one end over a polished tapered mandrel having an included angle of 60 deg until the actual average ID is increased 30 percent.

The expansion test shall be made in a die in order to restrict the expansion of 30 percent. The axis of the mandrel should be parallel to the axis of the tube during the expansion test.

8. Permissible Variations
The diameter of the tubing shall not vary from that specified more than the following amounts:

Outside Diameter, in	Outside Diameter, in.		Inside Diameter, in.	
	Plus	Minus	Plus	Minus
Below 3½ to 1½ inclusive	0.010	0.010	0.010	0.010
Below 1½ to 1, ID, inclusive	0.005	0.005	0.005	0.005
Below ½ ID	0.003	0.003		

When the outside diameter and wall thickness of ½ in. to 3½ in. OD tubes are specified, the outside diameter shall conform to the tolerances given in the above table, the wall thicknesses shall not vary from that specified more than plus or minus 10 percent. When less than ½ in. ID, the outside diameter shall conform to the tolerances given in the above table. The wall thickness shall not vary from that specified more than plus or minus 15 percent.

9. Pickle Brittleness
Tubing which is pickled to remove scale shall be treated to eliminate pickle brittleness.

10. Length
The tubing shall be furnished in random 4 to 8 feet lengths unless otherwise specified on the purchase order. When the length is specified, the tolerance shall be minus 0 plus ½ in. unless otherwise specified. When cut to length, the ends shall be free from burrs.

11. Packing
Material shall be packed according to the requirements of the transportation companies and of the purchaser.

12. Marking
Each length of tubing 1½ in. OD and over shall be steel stamped with the manufacturer's identification mark at a distance of approximately 1½ in. from the end. This mark shall be permanent but not deep enough to injure the tube.

13. All Boxes and Bundles Shall Bear the Following Information
Purchase order number, purchaser's specification number, manufacturer's name, size and gauge of material. In carloads, when shipped loose, shipping notices and tally sheets will show contents of car.

14. Terms of Rejection
Material failing to comply with this specification may be rejected and returned for replacement or full credit, at option of purchaser.

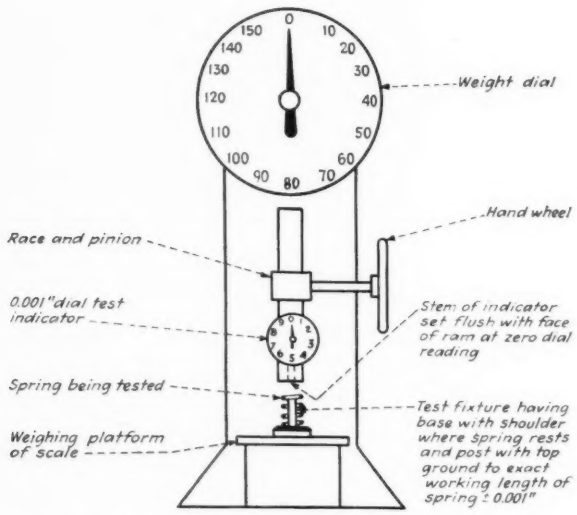
Recommended Practice

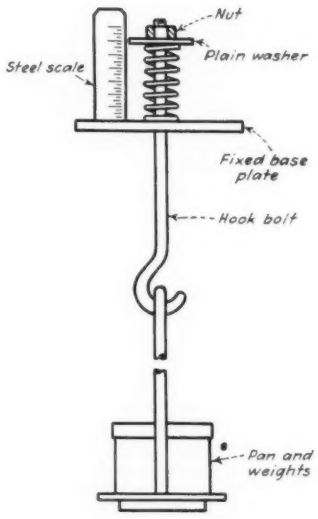
Pressure Regulators and Relief Valve Springs for Hydraulic Systems

This paragraph to be used for the guidance of plant maintenance personnel on the replacing of springs in hydraulic equipment.

Manufacturers recommended springs shall be used for replacement. When not immediately available substitute springs may be used in accordance with the following specification outlined. As soon as manufacturers springs are available they will replace the substitute springs.

Principles of Spring Calibrating Devices


Weight dial
Hand wheel
Race and pinion
0.001"dial test indicator
Stem of indicator set flush with face of ram at zero dial reading
Spring being tested
Test fixture having base with shoulder where spring rests and post with top ground to exact working length of spring ± 0.001"
Weighing platform of scale



SPRINGS WHICH ARE COILED from cold drawn wire should be made of G.M. 58-M. In general, the use of cold drawn wire should be restricted to wire diameters of 0.062 in. or less. Springs should be so designed as to limit loading to stresses of less than 80,000 lb per sq in. total torsional fiber stress.

For springs made from wire larger than 0.062 in., G.M. 64-M should be used.

Springs should be carefully tested on accurate calibrating devices. The best of these are based on the following principles as illustrated by the sketches shown above. The device on the left is preferred for its higher accuracy.

IN THIS DEVICE, an accurate scale has mounted upon it a sort of press ram actuated by rack and pinion with hand wheel, so as to provide a means of applying pressure to load the spring.

The pan, or weighing platform, of the scale is fitted with a pin or other aligning means, upon which is set a fixture having a broad base for steady support; a shoulder on top of the base, fitted to the end of spring to be tested; and a post fitted to the inside diameter of the spring and ground on top so that the distance from the shoulder to the top of the post is within ± 0.001 in. of the working or loaded length of the spring.

To use this device, the fixture and spring are laid on the scale pan and the scale set to zero by the tare adjustment. Then the dial test indicator is set to zero with a flat surface block held against the bottom of the ram.

When the ram is forced down onto the spring, the spring is compressed and the dial test indicator indicates the exact loaded height when the needle comes to zero. The weight, pressure, or load of the spring is then read directly from the scale dial.

Use of this device with various sizes of springs is facilitated if all the spring fixtures are close to the same weight. Then only the differing weights of the springs themselves must be tared to zero on the scale dial.

A LESS ACCURATE DEVICE for weighing springs is marketed by several tool firms and comprises a spring weighing scale with means for compressing the springs and a graduated steel length measuring scale. This will suffice where high accuracy is not required.

Where only an occasional check is required and accuracy is not necessary, springs can be weighed with a simple device as shown.

Industrial Time Controls—I

Types of Cycle Operation

Process factors and mechanical requirements that determine method of starting a time control on its cycle and type of cycle operation. Reset and non-reset features, means of adjustment, inclosures, and general construction arrangements obtainable in standard time controls are defined and discussed.

R. H. MECKLENBORG
Electrical Engineer
Automatic Temperature Control Company, Inc.

ENGINEERS are continually endeavoring to design machines that will produce more goods, and of a more uniform quality, with a lower expenditure of energy than has been done before. Today's impressive automatic machines and processes stand as a creditable new high in this endeavor. This achievement was made possible in no small measure by the development of industrial time controls. These devices are the fruits of a whole new field of process engineering.

Certain misunderstandings, arising from the undisciplined growth in this field, exist relative to operational limitations, variations in construction, and standards of quality of performance of industrial time controls. Design engineers generally agree that a proportionate balance should exist between total and component costs; yet many fine and relatively high-priced automatic machines and processes include time control devices that, by their imposed cheapness, fall far below the standards set for the installations themselves.

Whether a time control is to be started on its cycle or cycles manually by throwing a switch or pushing a pushbutton, or automatically by a limit switch or measuring instrument contact, is frequently predetermined by the nature of the application. Starting a time control by pushing a button or turning a switch is a non-automatic action and, therefore, reduces the automaticity of the total installation. If certain instants can be recognized only by a human observer; or if certain conditions such as color, position and shape can be recognized only by human senses; then manual starting of the time control program is of course unavoidable.

When any critical condition can be recognized by a mechanical, chemical, or electrical device, the advantages of automatic starting can be obtained. For example, if time-controlled cooling of a heat-treating furnace must start at a given temperature, human observation and manual starting of the time-controlled cooling can be replaced by a temperature-sensitive electrical contact (such as provided in an industrial contact-making thermometer) to start the time controlling device that accomplishes the cooling program as required.

Another example is time-controlled automatic mechanical movement. Where the machining of a piece of material is to commence when the piece reaches a certain position on the machine, limit switches tripped by the piece itself can be employed to start the time control on its program. Further examples can be cited of numerous processes, which are completely and automatically controlled, in which such devices initiate time programs.

Economic considerations are naturally paramount when one is deciding how much of a process to control automatically. The design engineer must base his decision on factors such as first cost, operating and maintenance costs, and the advantages that will accrue in production time, improvement of quality and safety of operation. The time control specialist can aid the process design engineer in making such decisions.

Before launching into a detailed discussion of time control devices, so that all discussion may be on common ground, a terminology and a system for making schematic diagrams will be established. As yet, no attempt has been made to establish industry-wide standards for these devices.

In schematic diagrams for time control systems that show the sequence and duration of operations, a waved line indicates that an operation is "on" or energized; a straight line indicates an "off" or de-energized condition, Fig. 1. Time dimensions may be added to the various on and off periods and to the total cycle, using the letters *s*, *m*, and *h* as abbreviations for seconds, minutes, and hours respectively.

Types of Cycle Operation

REPEAT CYCLE operation in a time control is that characteristic whereby its cycle is repeated over and over until shut off. When shut off, such as by opening the starting switch, the control may return to starting position or it may stay at the point of the cycle reached when shut off. Repeat cycle operation is used extensively in con-

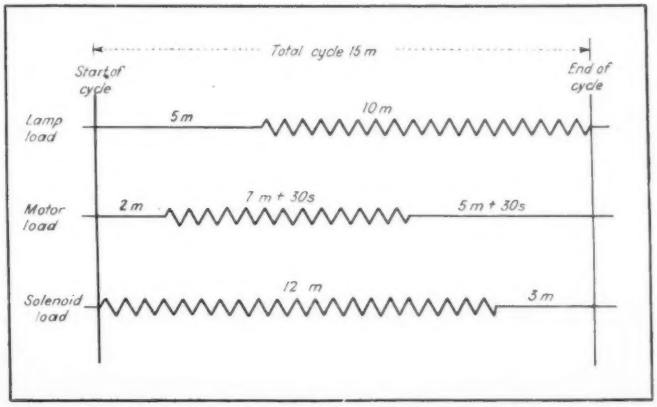


Fig. 1—Simplified method of drawing timing diagrams. Circuit is energized during periods indicated by waved lines. Straight bold lines designate time for off periods.

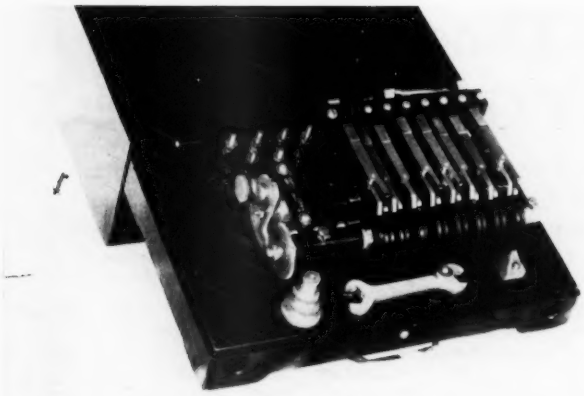


Fig. 2—Repeat-cycle type non-reset time control, mounted in a general purpose inclosure.

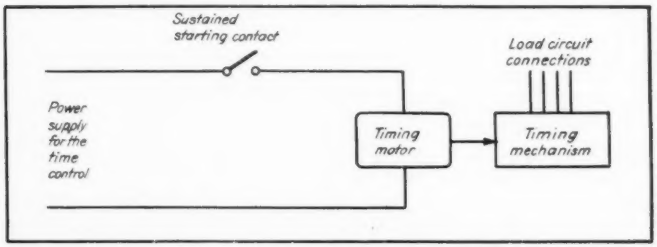


Fig. 3—Hook-up for repeat-cycle operation with an electrically driven timing motor.

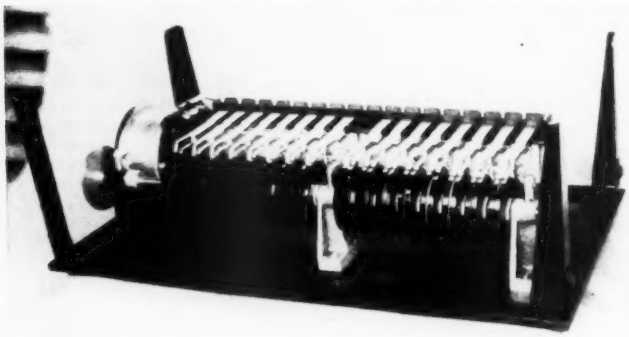


Fig. 4—Stop-cycle non-reset type of time control, stops after the completion of cycle.

tinuous automatic machines or processes. The unit shown in Fig. 2 drives continuously in one direction and repeats its program as long as the line switch is closed. Fig. 3 shows schematically the hook-up for repeat-cycle operation using an electric motor driven time control; the time control continues its cycle as long as the starting switch remains closed.

STOP-CYCLE operation means that a time control will proceed through one cycle and then stop until again started. In practice there are several variations of this definition. In some units the timing mechanism will return to its starting point when power fails or upon opening of its starting contact. In others, the timing mechanism will not reset when power fails but will proceed upon resumption of power to complete its program and return to the stop position. The non-reset motor-driven time control shown in Fig. 4 is stopped after its cycle is completed by the contact on left of instrument.

With the circuit shown in Fig. 5, the momentary starting contact (push-button) is closed to start the timing motor and held closed until the motor drive closes the stop contact. The starting contact can then be opened, and the time control will proceed through one cycle, its power supply being sustained by the stop contact. Upon reaching the stop position the stop contact is opened, stopping the time control.

The momentary starting contact, normally, must be held for one per-cent of the time control's total cycle, although special arrangements are frequently made to vary this duration for certain applications. One-quarter of a second is a reasonable average time for a person to hold down a push-button. When one percent of the total cycle time is too long to expect an operator or a machine-motion to keep the momentary starting contact closed, operation as outlined in Fig. 6 may be used.

In the arrangement shown in Fig. 6, the momentary starting contact, such as a tripped limit switch, when closed energizes the motor and a relay or solenoid. This relay or solenoid then closes the stop contact quickly. Normally the duration of time required for closure of the starting contact to assure closing of the stop contact is of the order of one twentieth of a second. At the end of the cycle, the stop contact is broken by the mechanism.

A stop-cycle time control can be electrically connected to get over-all repeat-cycle action by merely holding the starting contact closed throughout any number of time control cycles. Then when the starting contact is finally opened, the stop contact may continue to energize the time control motor around to the stop position before shutting off the time control; or the stop contact may release immediately and discontinue the cycle at that point. Many assemblies contain endless combinations of these repeat-cycle and stop-cycle time controls.

Reset and Non-Reset Features

RESET is a feature of a time control that provides for action of the timing mechanism when its holding-in device such as a clutch is energized. When this device is de-energized, the timing mechanism returns quickly to start of cycle position. In an electric motor-driven time control, the usual arrangement is to clutch the motor drive to the timing mechanism when a solenoid-operated clutch is energized, Fig. 7. Upon breaking of the solenoid circuit, by failure of line power or otherwise, the timing mechanism is declutched and then returned by a spring

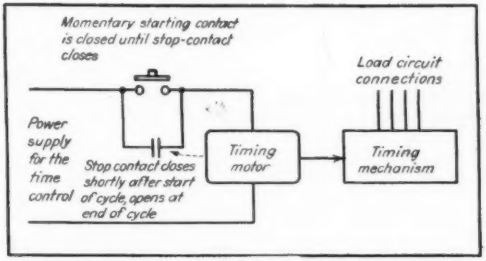

Momentary starting contact is closed until stop-contact closes
Load circuit connections
Power supply for the time control
Stop contact closes shortly after start of cycle, opens at end of cycle
Timing motor
Timing mechanism

Fig. 5—Stop-cycle operation scheme in which the motor drives the stop-contact shut after being started by the pushbutton.

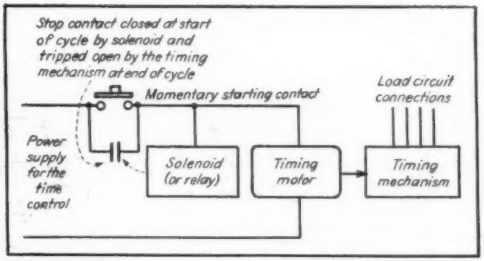

Stop contact closed at start of cycle by solenoid and tripped open by the timing mechanism at end of cycle
Momentary starting contact
Load circuit connections
Power supply for the time control
Solenoid (or relay)
Timing motor
Timing mechanism

Fig. 6—Scheme for stop-cycle operation for initiating a long timing cycle that uses a momentarily closed starting contact.

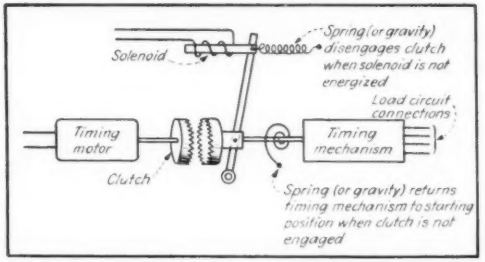

Solenoid
Spring (or gravity) disengages clutch when solenoid is not energized
Load circuit connections
Timing motor
Timing mechanism
Clutch
Spring (or gravity) returns timing mechanism to starting position when clutch is not engaged

Fig. 7—Resetting action used in time controls. When solenoid is de-energized, timing mechanism returns to starting position.

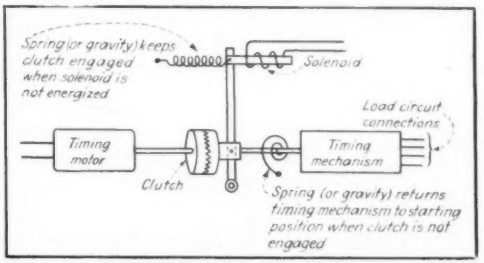

Spring (or gravity) keeps clutch engaged when solenoid is not energized
Solenoid
Load circuit connections
Timing motor
Timing mechanism
Clutch
Spring (or gravity) returns timing mechanism to starting position when clutch is not engaged

Fig. 8—Typical reverse-action reset mechanism used in motor driven time controls. Clutch is normally engaged by a spring.

or gravity to starting position. There are many variations of this arrangement in industrial practice.

REVERSE-ACTION RESET in a time control provides for action of the timing mechanism when the holding-in device is not energized. When it is energized the timing mechanism is returned quickly to start of cycle position. In arrangements used with motor driven time controls, the motor drive is normally linked to the timing mechanism through a clutch that is kept engaged by a spring, Fig. 8. The solenoid when energized disengages the clutch thus permitting the return spring to snap the timing mechanism back to starting position. Should line power fail, this arrangement prevents the timing mechanism from returning to its starting position. For this reason, this action is desirable in many applications.

ELECTRICAL RESET provides resetting by electrical means. A dual motor driven time control in which one motor is used for normal drive of the timing mechanism and the other for a high-speed return to the starting position is an example of electrical reset. Another is the condenser-discharge circuit of an electronic time unit.

MANUAL RESET provides for resetting by hand. The motor-driven slip clutch type of time device, widely used in photographic exposure timing, that is reset by hand after each time interval is an example of manual reset.

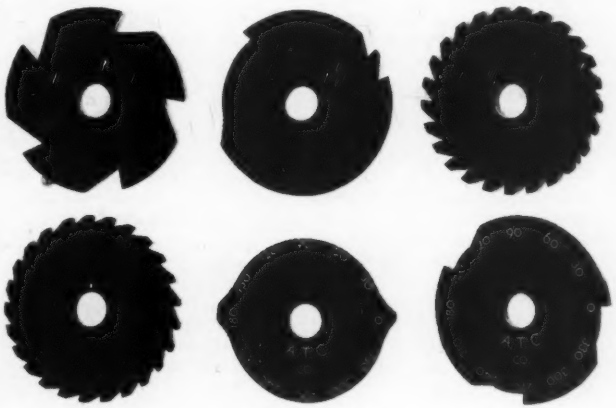


Fig. 9—Special machine cut precision cams used on reset and non-reset time controls.

NON-RESET is a characteristic of a time control whereby the driving unit is rigidly linked to the timing mechanism. The arrangement shown in Fig. 3 is an example. Reset action is not possible with this arrangement.

Types of Adjustment

Some time controls are designed so as to exclude any possible adjustment of the controlled time periods. Such a unit may make use of fixed-cut cams, Fig. 9, their use does not permit any adjustment of timing after manufacture. This feature is frequently desirable to maintain low cost, or to assure that timing settings cannot be modified by unauthorized persons. Others are factory adjusted, meaning that adjustment of the time periods must be done by the manufacturer at his plant at the time of final assembly and are not normally readjustable after that.

TRIAL AND ERROR ADJUSTMENT indicates that the time-adjusting mechanism lacks a scale, a dial, or other refer-

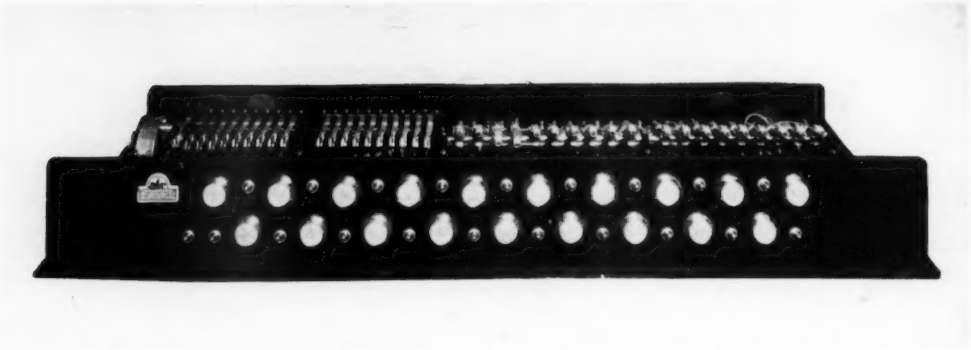


Fig. 10—Non-reset control with lamps indicate progress of cycle. Open silver and sealed mercury contacts are used.

ence. The time intervals are adjusted by either the manufacturer or the user by repeated tests and re-adjustments of the settings of cams.

INFINITE ADJUSTMENT is provided by a timing mechanism that permits fixing of the time intervals at any value on its dial or scale between the time control's minimum and maximum values.

STEP ADJUSTMENT provides only a limited number of definite marked time interval positions and will not permit adjustments at points between these positions.

VISIBLE ADJUSTMENT means that the scales or dials on which the time intervals have been set are visible when the time control is in normal operation in its inclosure.

NON-VISIBLE ADJUSTMENT indicates that the scales or dials on which the time intervals have been set are not visible when the time control is in normal operation as in a totally inclosing housing.

INTERNAL ADJUSTMENT is provided by knobs or tools that are not accessible from the outside of the time control when in normal operation.

EXTERNAL ADJUSTMENT indicates that the adjustment means are accessible from the outside of the inclosure. The operational and economic advantages and disadvantages of these adjustment features will vary from application to application.

Indication of the progress of the program of a time control is usually an optional feature; it may be one of the following types, or it may be of other less frequently employed designs.

DIAL INDICATION is the term used when the progress of a cycle is indicated by the travel of a pointer around a circularly graduated dial. Normally the dial is used for time settings and is visible from the outside of the time control inclosure. In a common variation of this construction the dial rotates while a reference pointer stays in place. Dial Indication can be used on reset or non-reset time control constructions.

SCALE INDICATION may be vertical or horizontal and is naturally limited to use on reset timers since it does not provide for continuously repeating cycle indication.

DISK INDICATION is provided by the movement of a disk graduated along its edge. This construction may also be used to obtain references for time adjustments. Disk indication is especially practical when the line of viewing is at right angles with the rotary motion of a time control and can be used equally well on reset and non-reset time control mechanisms.

LAMP INDICATION describes the use of indicator lamps to show the progress of the cycle. This method naturally gives only step-by-step indications rather than a continuous, smooth action. The steps of the cycle so indicated may be increments of time or may be certain critical stages in the program cycle. Lamp indication may be external to or a component part of a time control, Fig. 10, and may be employed equally well with reset and non-reset action.

Simple variations of these methods of cycle progress indication may be employed to indicate merely the fundamental conditions of a time control's cycle such as: Time control dormant, Time control in operation, and cycle completed.

Time Control Inclosures

The National Electrical Manufacturers' Association classification of inclosures for general industrial control apparatus applies directly to most time controls. These are outlined here with merely differentiating remarks. Details of good or required construction can be obtained from the NEMA Standards and the applicable Underwriters' Laboratories specifications.

TYPE I General Purpose Inclosures are designed to meet the Underwriters' Laboratories general specifications and are primarily for protection against accidental contact with dangerous voltages. A Type I case is suitable for general purpose application indoors and in places where atmospheric conditions are normal. It serves to protect time controls against heavy dirt and light indirect splashing but is not dust tight. Type I-A Semi-Dust Tight cases are similar to Type I, with the addition of felt or similar gasketing around the covers. Such a case is suitable for general application indoors and provides additional protection against dust, although it is not dust tight.

TYPE II Drip Tight inclosures are sheet metal cases similar to Type I, with the addition of drip shields or their equivalent. They are suitable for application where condensation may be severe, as in cooling rooms and laundries, to protect timing equipment against falling water.

TYPE III Weather Resistant cases are of cast construction, or of sheet metal of suitable stiffness, designed to afford protection against weather hazards, such as rain and sleet. Normally noncorrosive hardware and compressed rubber gaskets are used.

TYPE III cases are suitable for outdoor use on docks, canal locks and construction work, and also for application in subways and tunnels.

TYPE IV cases are water-tight and are of cast construction or of stiff sheet metal. They are designed to meet a

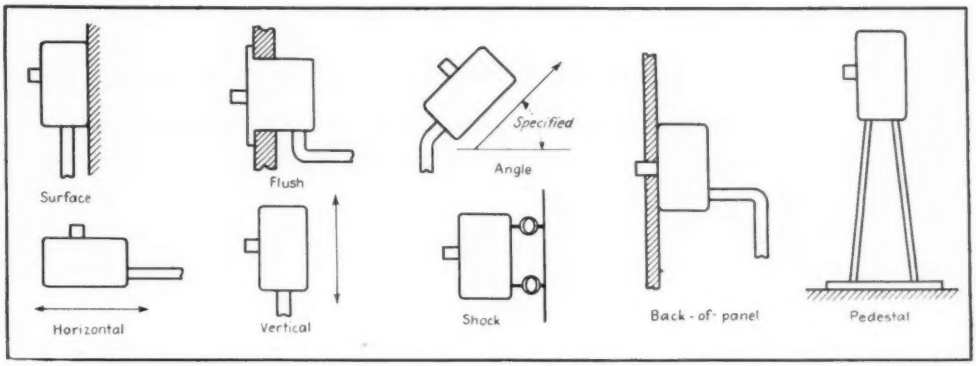


Fig. 11—Some arrangements used in mounting time control devices to obtain ease of installation or ready accessibility.

hose test as described in NEMA Standard IC50-43. These cases are suitable for application outdoors, on shipboard, on docks, in dairies, breweries, and places where they may be subjected to heavy drenching.

TYPE V Dust Tight cases may be of cast or sheet metal construction. To exclude dust, they have ground-flanged, gasketed or threaded joints and openings. They meet the requirements of the National Electrical Code for Class III, Division I locations. Such cases are suitable for application in steel mills, cement mills, and other locations where it is desirable to exclude dust to protect the inclosed time controls, as well as to prevent the electrical contacting arcs from starting fires.

TYPE VI cases are suitable for application where time controls may be subject to submersion in water, as in quarries, mines, and man-holes. The design will depend on the specified conditions of pressure and duration of submersion. Wiping joints for cable connections may be provided as part of this construction.

TYPE VII cases are designed to meet the applicable requirements of the National Electrical Code for Class I, Group D Hazardous Locations (atmospheres containing gasoline, petroleum, naphtha, alcohols, acetone, lacquer solvent-vapors, and natural gases.) Such explosion-proof cases are provided with strong walls and large metallic cooling surfaces across flanges, threads, and shafts. An internal explosion should force only cooled, safe gases to the outside. A similar construction, with or without gaskets, is required for dust tight cases for Class II, Division I locations.

There are other specialized constructions for time control inclosures, the details and uses of which are governed by Underwriters' and NEMA regulations. In addition to these types of construction, inclosure mounting arrangements usually must be considered. In Fig. 11 some of the mounting schemes in common use are indicated in sketch form.

General Construction Arrangements

When a manufacturer assembles time controls into his own control system and control equipment, it is most economical for him to purchase time controls that are uninclosed and even unwired. But in doing so he should be sure to provide ample space in his housings for mounting and operation of the controls. Assembly of the time controls into his system and the time adjustments on them then become the system manufacturer's responsibility from the standpoint of the final user. When time controls are installed in this manner, they can usually be manufactured in considerable quantities, and special units can therefore be made up to suit the customer's needs exactly. Further savings can, of course, be made if he uses standard time control devices minus cases and perhaps wiring.

When, on the other hand, a manufacturer of the machine or process to be time-controlled does not supply the needed controls, the ultimate user is best advised to make use of standard time controls. In such installations, since inclosures are not normally existing, these time controls should be purchased complete with suitable cases. This arrangement leaves the responsibility of selection up to the user and the responsibility for successful operation up to the time control supplier. Since standard time controls are produced in sizeable quantities, the user is not put to the expense of a special design; although he may have to accept some flexibilities and ratings that his particular application does not need in order to make use of a standard item.

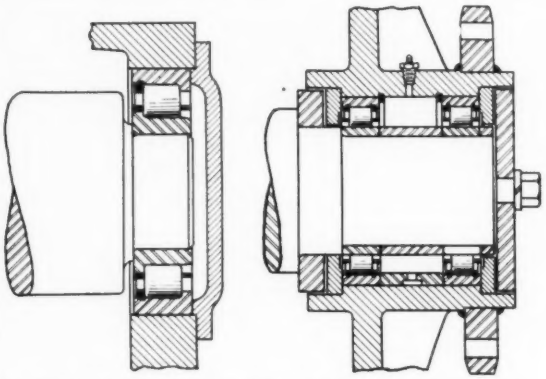
In the situation where a manufacturer's control system consists chiefly of standard electrical devices, or time control units, or of both, it is most economical for the time control supplier to include the common electrical devices along with the time control assemblies required and to supply the entire control system in one inclosure, wired up, adjusted, and ready for easy installation and prompt operation, all in a unit-package assembly.

By following this procedure, the overall engineering is done by the company actually building the most specialized devices, about which there is the least general knowledge, namely the time controls. Incorporation of the standard control equipment, being a less specialized operation, can then be done as well and as inexpensively by the time control supplier as by anyone else. This plan is logical too; the time controls for an automatic process are the most critical and dominant of the control units employed, and the selection of other control equipment should be based on a thorough understanding of the needs of the timing circuits and not the other way around. Responsibility for the successful operation of the entire system will lie with the time control supplier when such completely engineered unit-package time systems are used, also appreciable savings in labor and engineering effort will usually accrue to manufacturers of automatic machinery and their users.

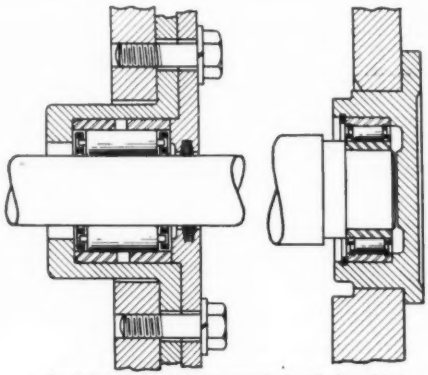
EDITOR'S NOTE.—Part II of this article will cover characteristics of synchronous, induction, and other motors with associated drive arrangements for time controls. Electronic circuits for timing, general construction and operation of dash-pot and other timing mechanisms will also be discussed.

Housings and Mountings for

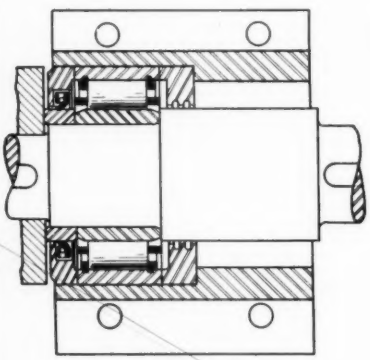
Choice of bearing support is determined by the type of loading encountered, mounting



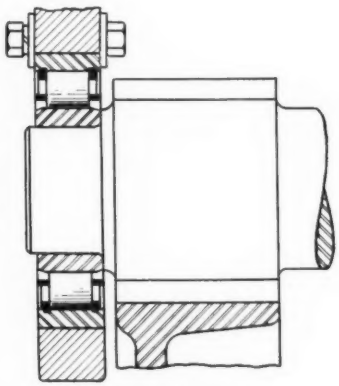
Through-bore housings with cover plate (left) and end counterbores (right)



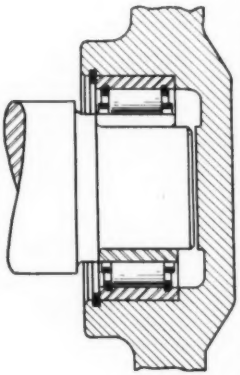
Cartridge mountings with oversized, adjustment holes (left); shoulder and snap ring (right)



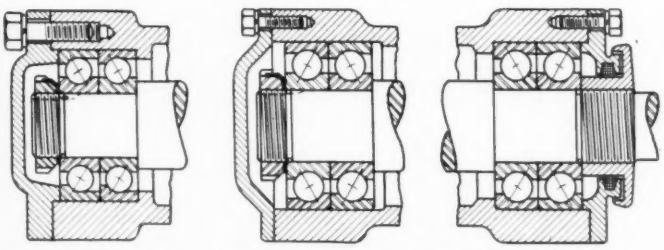
Cartridge mounting in split case



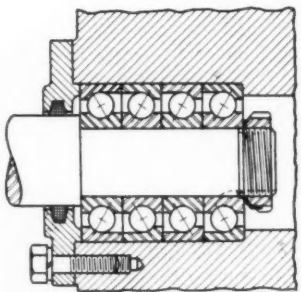
Pedestal type housing



Solid-end housing



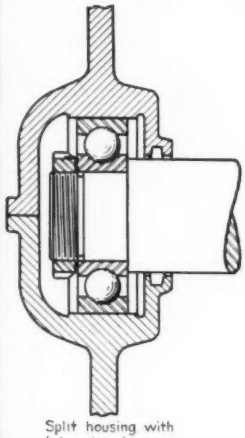
Double-bearing mountings -- tandem for thrust loads (left), back-to-back for radial loads (center), face-to-face for thrust and radial loads (right)



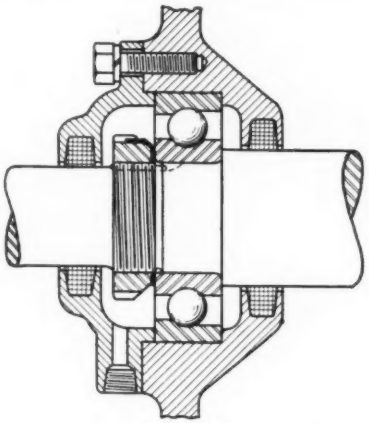
Combination mounting for thrust in either direction

Ball and Roller Bearings

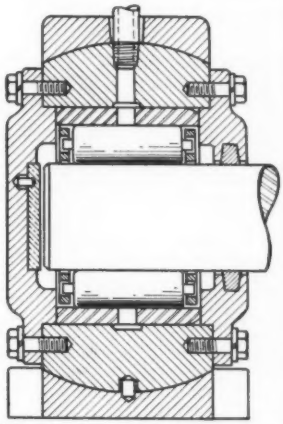
space available, degree of accessibility desired, and the position of the bearing.



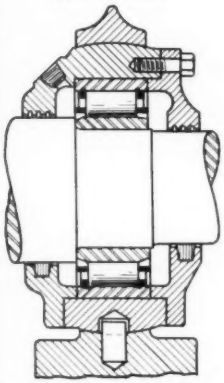
Split housing with integral end covers



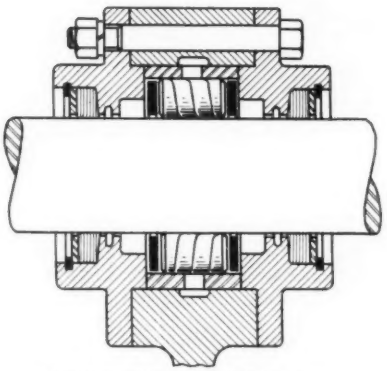
Integral housing with one shoulder



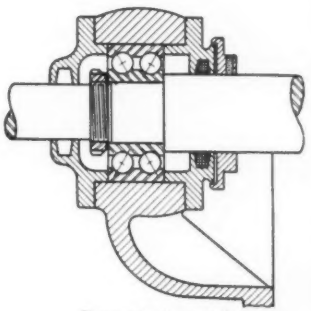
"Elastic" mounting for slow misalignment



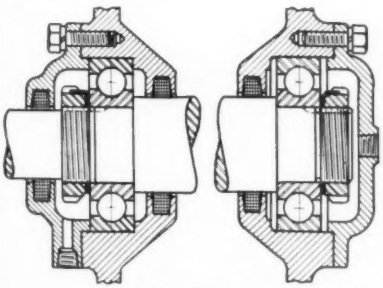
Self-aligning pillow-block housing



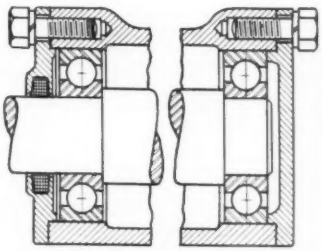
Bracket mounting with piloted covers

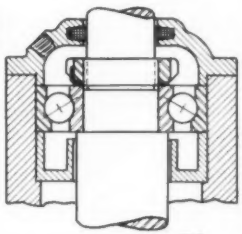


Removable-bracket housing



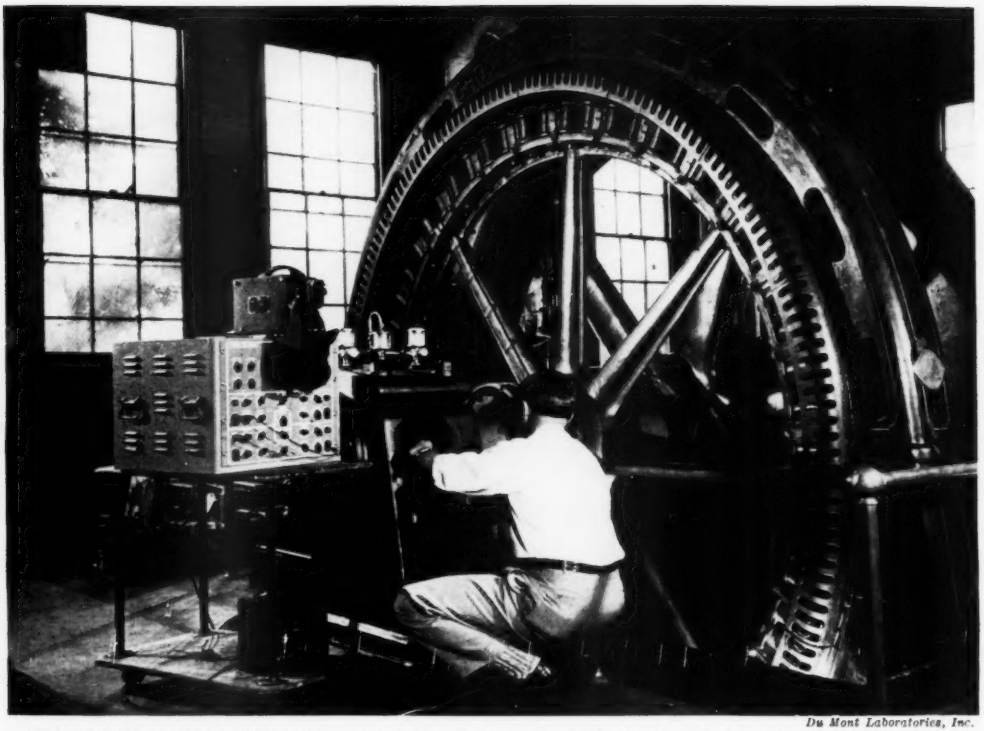
Typical two-bearing horizontal mounting -- standard (left), opposed (right)





Typical vertical mounting

Sketches courtesy of Marlin-Rockwell Corp.; Hyatt Bearings Div., and Roller Bearing Co. of America.



Du Mont Laboratories, Inc.

CATHODE-RAY OSCILLOGRAPH indicates magnitudes and frequencies of vibrations in main bearing of an alternator. Special camera mounted over fluorescent viewing screen records oscillograms of vibration patterns during periods of several hours.

The Cathode-Ray Oscillograph As a Design Tool

Instrumentation for analyzing transient phenomena occurring in high speed machinery. Energy conversion pick-ups, cathode-ray tube and instrument characteristics. Five case histories.

THE HIGH ORDER of vibration and stress frequencies developed in high speed machinery cannot be measured by the mechanical indicating devices formerly used on slow moving machinery. Therefore, many problems concerning transient phenomena of this higher order remained partially or wholly unsolved for lack of a suitable indicating instrument. Although usually considered an electrical engineer's tool, mechanical engineers are finding that the cathode-ray oscillograph is indispensable for solving many problems requiring the measurement of high frequencies, extreme velocities, dynamic stresses and similar high speed quantities.

To utilize this versatile instrument, mechanical movements or deflections resulting from the loading of machine parts must be converted into equivalent electrical impulses. This transformation is accomplished by one or more of the many types of pick-ups, sometimes called transducers. Typical of these are strain gages, potentiometers, photocells and snap switches. Fig. 1 lists the various types of transducers schematically and shows their relationships to the actuating source and oscillograph. A special power source and bridge circuit with amplifier is necessary to create desired signal characteristics.

In dealing with the broad mechanical field in which motions, vibrations, pressures and forces occur in combination, certain types of transducers, notably strain gages, are used in more than one type of study. Gages that indicate strain can be of the resistance, capacitive or inductive type.

Several pieces of test equipment are required when studying a specific problem, as, for example, the stresses occurring in a railroad track as a train travels along at high speed.

The movement of the wheels and the stresses in the rail under them must be recorded. Two types of pick-ups or transducers are required. One, a light

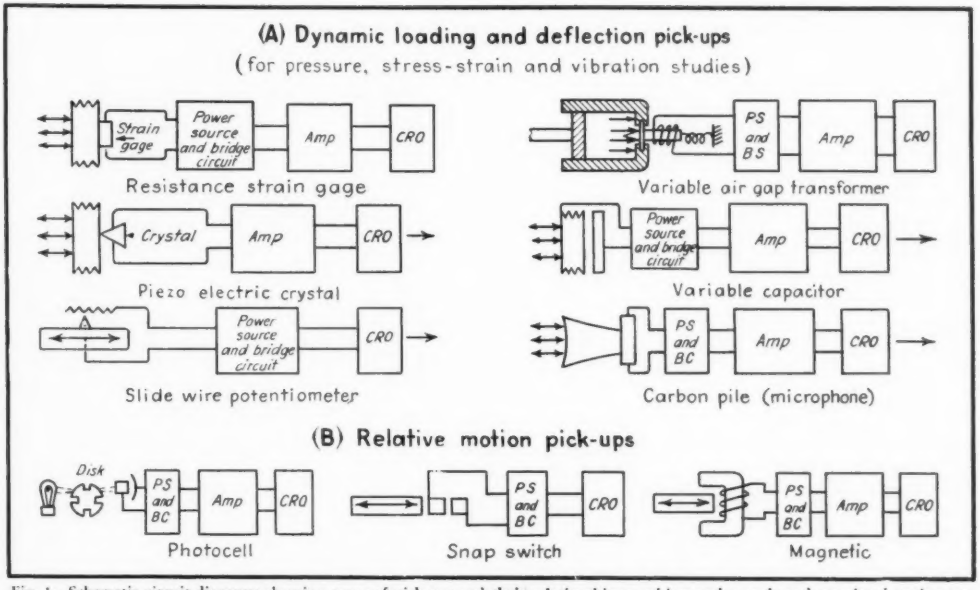
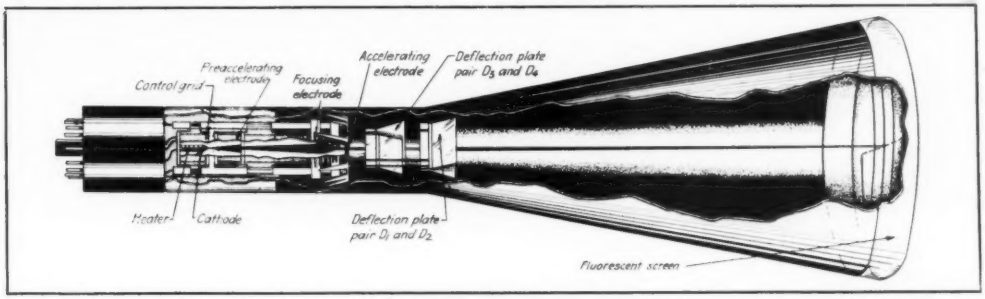


Fig. 1—Schematic circuit diagrams showing types of pick-ups and their relationship to subject under study and associated equipment.



Du Mont Laboratories, Inc.

Fig. 2—Cutaway view of cathode-ray tube showing elements of "electron gun." Deflection plates move projected beam across screen.

source and photocell at each end of the section of track being checked for indicating wheel movements; the other, one or more strain gages mounted on the rail for recording the stresses produced in the track.

The small voltage impulses in the two pick-up circuits must be amplified before being fed into the oscillograph. In the strain gage circuit, a calibrated resistance bridge is also necessary so that positive control of gage resistance can be obtained.

In analyzing this or any problem, the oscillograph does not offer the solution to a problem but only supplies data regarding the nature of the problem, in the manner of a voltmeter. Such information serves as a guide in the analysis of the phenomenon under study. Nor is it a corrective instrument that in itself performs a specific operation on an electrical signal or on its source. Rather, the oscillograph is an indicator that displays visually on the fluorescent screen of a cathode ray tube the essential characteristics of the signals, regardless of complexity.

Cathode-Ray Tube

An outline drawing of a modern high-vacuum electrostatic focus and deflection cathode-ray tube is shown in Fig. 2. A heater element mounted within a cathode sleeve heats an oxide coating on the end of this sleeve causing electron omission. The electric field produced by the control electrode or grid and the preaccelerating electrode, connected internally to the accelerating electrode, acts to draw the electrons emitted from the cathode into a narrow beam having a minimum cross-section in the vicinity of the grid.

From this point the electron beam diverges until it reaches the region of the focusing electrode where the electric fields set up by the preaccelerating, focusing and accelerating electrodes cause the beam to converge. This entire beamforming structure is known as the "electron gun."

After leaving the "gun", the electron beam passes between the plates D3 and D4 of the deflection-plate pair and then between the plates D1 and D2 of the pair. A potential difference applied between plates of the pair D_1 D_2 produces an electric field that deflects the electron beam in a direction perpendicular to the plane of those plates. Similarly, a potential applied between plates of pair D_3 D_4 results in

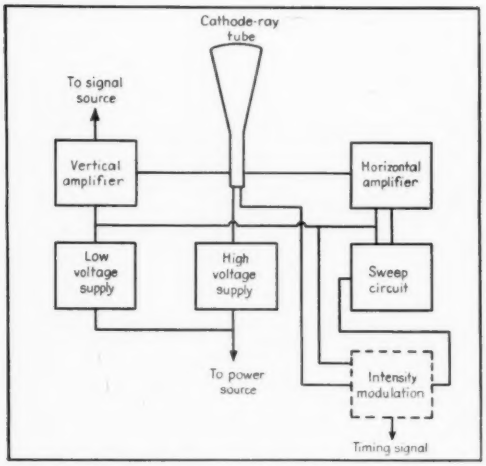


Fig. 3—Diagram of components in a cathode-ray oscillograph.

Du Mont Laboratories, Inc.

Fig. 4—General-purpose instrument equipped with 5 in. screen.

deflection of the beam in a direction perpendicular to the plane of these plates. It is possible to control position of the spot on the screen by two potentials applied to the two sets of plates.

Several circuit components, in addition to the cathode-ray tube, make up the complete instrument. Fig. 3 is a block diagram of a typical oscillograph. To produce a spot on the fluorescent screen, a power supply is used for applying the proper voltages to the various electrodes of the tube. Although accelerating potentials of at least 1,000 volts are necessary, only about 100 microamperes of current are flowing in the electron beam toward the fluorescent screen. Different voltages applied to the tube electrodes are for focusing, accelerating and positioning the electron beam so that a small, yet visible spot is produced to trace the curve on the screen.

The combination of the cathode-ray tube and power supply is enough to form the indicator element. As the tube itself is a relatively insensitive device, potentials in the order of several hundred volts are necessary for full-scale deflection. In most applications, input potentials are of low magnitude and, therefore, amplifiers are necessary to supply voltages for both X-and Y-axis deflection of the beam. A Z-axis amplifier can be used to impress timing markers on the pattern when the tube grid is positive, or as breaks in the curve when the grid is negative.

Ordinarily, when using string galvanometers or pen-and-ink recorders, there is a definite limit on the range of frequencies that can be reproduced. In the cathode-ray tube, the beam has no inertia and thus no frequency limitation. When an amplifier is imposed between the signal source and the deflection plates or electrodes that move the electron beam, the signal is faithfully reproduced when the limitations of the amplifier are not exceeded.

A d-c voltage, controllable in magnitude, is used to position the beam in both horizontal and vertical directions. The positioned beam is then made to trace a wave form on the tube screen by simultaneously impressing an a-c sine wave on the vertical-axis deflection plates and a saw-tooth wave on the horizontal-axis deflection plates.

For most applications, the signal applied to the horizontal deflection plates provides for the movement of the spot at a uniform rate with respect to time. Such a signal generated within the instrument provides the time-axis along which is plotted the unknown variable voltage. After the spot has travelled the width of the screen, it snaps back to its starting position and the process is repeated.

The linear time-base generator, or sweep generator, is the integral part of the oscillograph that generates saw-tooth voltage for the linear time-base. The sweep oscillator is characterized by its ability to synchronize its own frequency of oscillation with the frequency of the unknown signal so that, in cases of recurrent phenomena, the spot begins its excursion during each period at the same point on the wave of the unknown. The luminescent pattern that results therefrom is a stabilized wave. With the pattern "locked in", the rapid retrace of the wave many times a second appears to the human eye as an image, because of the persistence of the phosphorescent tube screen and of human vision.

As in the study of the moving train above, it is often necessary to record an action that does not recur but which exists for a short time interval, and then disappears. Such an occurrence is called a transient. If the ordinary sweep oscillator were used, the horizontal travel of the spot corresponding to wheel movements would be entirely independent of the transient and the observer would have no assurance that the beginning of the unknown wave occurred at the beginning of the spot's excursion across the screen. This possibility is provided for by a single-sweep circuit that generates a time-base only when a transient initiates it.

A typical general-purpose oscillograph well suited for studying low-frequency phenomena such as pressure variations and mechanical motions is shown in Fig. 4. It has a high-sensitivity vertical deflection of 0.01 rms volt/in., that is, for every 0.01 rms volt of signal applied to the vertical axis, the spot will be deflected one inch. It also has a vertical amplifier sinusoidal frequency response uniform within 10 percent from 2 to 100,000 cps and can handle recurrent phenomena from 2 to 50,000 cycles per second.

Other types of instruments contain a variety of component circuits that produce special characteristics such as:

1. Amplifiers with wide frequency response (to 11 megacycles).
2. Intensity modulation from external signal.
3. Special timing oscillator.
4. Circular time base.

The effectiveness of the cathode-ray

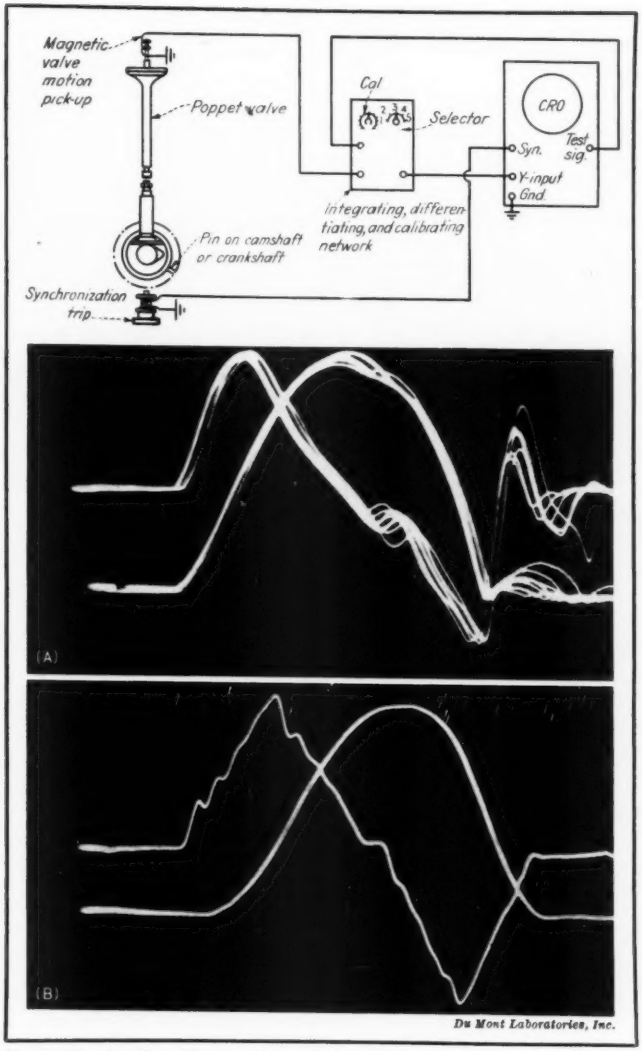


Fig. 5—Circuit and oscillograms for study of combustion engine valve mechanisms.

oscillograph as a design tool is illustrated in the following case histories. In each instance, this instrument proved to be a simple and accurate medium for obtaining analytical data.

PROBLEM 1 (Fig. 5)—To study the motions of internal combustion engine valve gear mechanisms.

METHOD—Output from the magnetic pick-up is proportional to the valve velocity. Special electrical network serves to integrate or differentiate the velocity curve to obtain valve lift and acceleration curves. Synchronizing trip indexes cam or crankshaft speed with the horizontal linear sweep circuit of the oscillograph. Disturbances shown on lift and velocity curves in Fig. 5-a indicate a flexible cam shaft. Fig. 5-b shows the same curves after shaft has been stiffened.

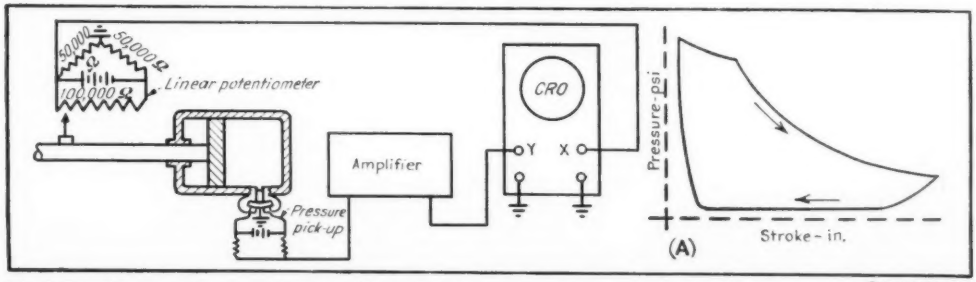
With the pick-up magnet mounted on the valve head, observations are made while engine is driven by a dynamometer. If valve mechanism permits mounting pickup on top of valve stem, data can be taken with the engine firing.

PROBLEM 2 (Fig. 6)—To observe the pressure-stroke characteristic of an air ram.

METHOD—Ram displacement is measured by a rotational wire-wound linear potentiometer driven by an endless cable attached to the ram. Voltages proportional to the changing resistance of the potentiometer are impressed on the X-axis.

The pressure pick-up consists of a small light piston that presses against a leaf spring. Two strain gages mounted on the spring form part of a Wheatstone Bridge circuit. The gage signal representing pressure exerted on leaf spring is fed into the Y-axis. Reproduced oscillogram, Fig. 6a, takes the shape of the well-known "indicator diagram" in which vertical deflection represents pressure and horizontal deflection the stroke or displacement.

(*continued on next page*)



Bucyrus-Erie Co.

Fig. 6—Potentiometer and pressure pick-ups used in study of air ram characteristics. Reproduced oscillograph trace is shown at right.

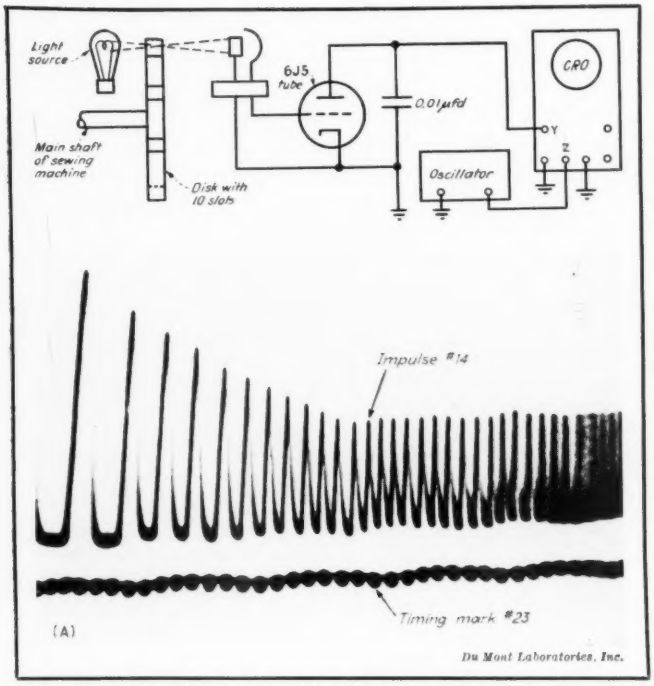


Fig. 7—Photocell and slotted disk provide timed pulses for studying sewing machine starting characteristics. Marked traces indicate instant machine reaches full speed.

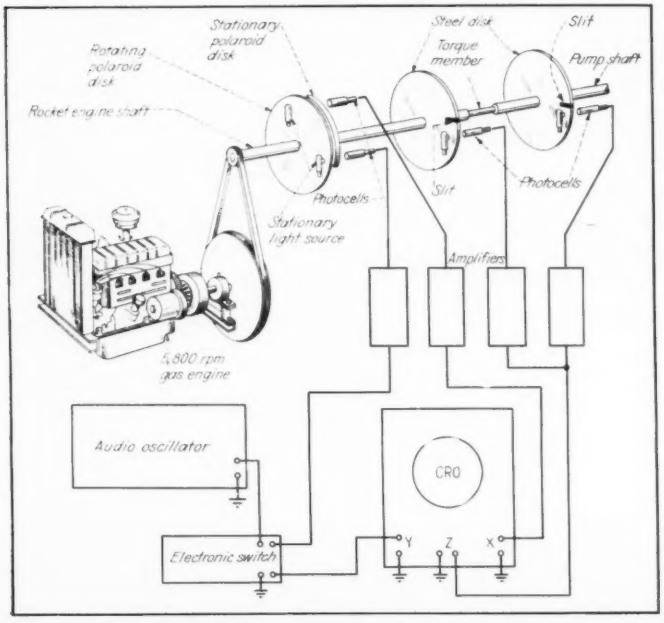


Fig. 8—Three-axis oscillograph indicates speed and drag torque of rocket engine fuel pumps. Rotating disk and photocells produce impulses in switch-oscillator circuit.

PROBLEM 3 (Fig. 7)—To examine the starting characteristics of a sewing machine as to the number of cycles and time required to reach full speed.

METHOD—Light source is interrupted by the rotating disk containing ten slots. Impulses from the photocell are fed through the 6J5 tube and capacitor circuit and appear as sawtooth waves with varying amplitudes proportional to machine speed. The calibrated audio oscillator impresses 500-cycle markers on the Z-axis of a single sweep oscillograph. This type of instrument is needed for synchronizing the horizontal motion of the beam with the start of the sewing machine.

Twenty-three 500-cycle markers (Fig. 7a) can be counted from the time the machine starts until it reaches full speed, as indicated by the constant amplitude pulses. This number of markers corresponds to 46 milliseconds. Fourteen pulses on the main curve occur in this time interval. There being ten slots in the rotating disk, 1.4 machine revolutions or cycles are completed before full speed is reached.

PROBLEM 4 (Fig. 8)—To check rpm and torque of rocket engine fuel pumps.

METHOD—The output of the photocells mounted behind the Polaroid disks is fed to two voltage amplifiers. One amplifier is conected to the X-axis of the oscillograph. The output of the other is connected to the input of the electronic switch, and the output of the electronic switch is connected to the Y-axis of the oscillograph. To the other input of the switch an audio frequency oscillator is connected.

A circle of 4-in. dia is produced on the oscillograph screen when the oscillator is tuned to the frequency of the Polaroid generator. The frequency in cycles per sec of the oscillator multiplied by thirty gives the revolutions per min of the shaft when generator provides two cycles per revolution.

The slotted steel disks mounted on each side of the pump shaft torque member energize individual photocells. Output of these cells is fed through separate amplifiers to the Z-axis of the instrument. Two dark spots, one for each cell, are superimposed on each other on the circle developed by the Polaroid generator.

The spot remains true as long as no load is applied on the torque side of the pump. However, when loads are applied, an angular displacement of the torque member is produced, causing the superimposed spot to move an equivalent angle. Angular displacement between spots is then measured.

PROBLEM 5—(Fig. 9)—To study the damping characteristics of a GR-S rubber automotive engine mount.

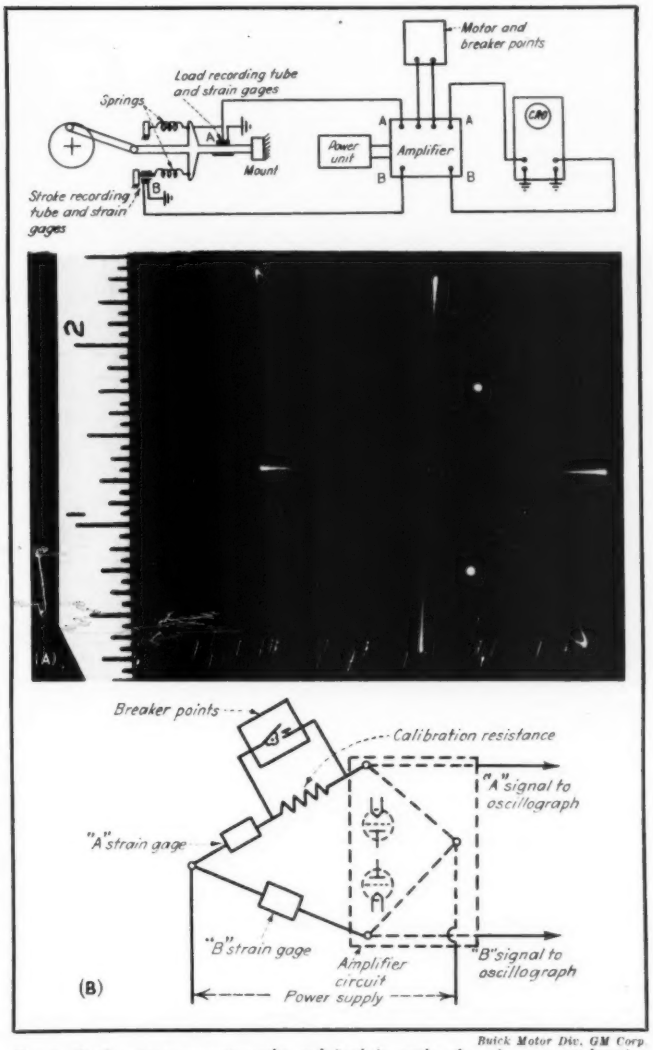
METHOD—Load variation and stroke are measured by SR-4 strain gages cemented to the recording tubes. The oscillograph signal resulting from the amplified gage impulses is calibrated by means of a calibrated resistance and the motorized breaker points. Fig. 9a shows the mount running under compression and tension loading. That part of the signal to the left of the vertical axis represents compression, that to the right, tension. The hysteresis loop represents a nominal load variation of 1,500 lb and a stroke of 0.250 in. and indicates an efficiency of 70 percent.

In Fig. 9b is shown only the function of the breaker points in the circuit. This calibration device is not synchronized in any way. It merely inserts a calibration resistance in one branch of the network and then quickly shorts it out. This gives a vertical deflection to the otherwise stationary signal on the oscillograph. The ratio of this deflection caused by a known resistance and the deflection caused by the varying strain gage resistance can be used to calibrate the vertical scale on the oscillograph.

Each strain gage consists of a number of loops of very fine wire laid parallel to the axis and cemented securely to the recording tube. As the tube is alternately compressed and elongated in stroking the mount, the strain gages are also compressed and elongated resulting in a constantly changing resistance. This change of resistance is proportional to the change in length that is in turn proportional to the force being exerted on the tube. Thus, the amplifier circuit experiences only the changing strain gage resistance. Dividing load variation by the stroke in inches gives the rate of the mount in lb per inch.

The stroke recording tube operates in the same manner. Inasmuch as the tube will not elongate as much as the stroke, a pair of springs is inserted between the tube and the reciprocating shaft. These springs have a constant rate and therefore transmit a force to the tube proportional to the displacement of the shaft. Thus, the tube is elongated in direct proportion to the stroke and the resulting changes in strain gage resistance give a signal that is proportional to the stroke.

These case histories cover only a few of the many applications of the oscillograph. It has been used in almost every phase of mechanical design. A few types of other problems successfully studied include analysis of: Locomotive reversing gear motions; Pressures created inside a gun barrel; Whirl-pit velocities; Beam deflections; Impact stresses in aircraft landing gears; Loom shuttle timing; Propeller blade vibrations; Anti-knock characteristics of fuel; Turbo-propeller characteristics; and Cavitation in hydraulic systems.

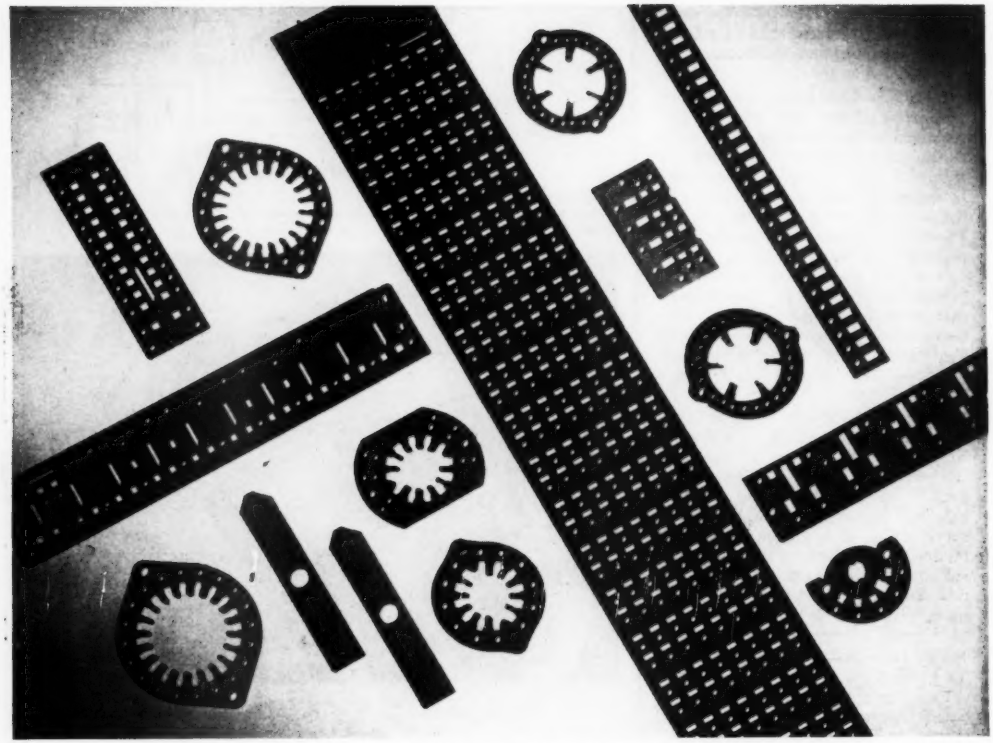


Buick Motor Div., GM Corp.

Fig. 9—Strain gages measure stroke and load in study of engine mount damping characteristics. Hysteresis loop shows GR-S rubber in tension-compression cycle.

A dozen companies manufacture about twenty different types of cathode-ray oscillographs. Small, portable instruments suitable for routine circuit checking cost about $100, while large multi-circuit units for the study of complex wave forms cost $2,000.

EDITOR'S NOTE: Much of the data used in this article were obtained with the cooperation of the Allen B. Du Mont Labs., Inc. We also acknowledge the help of J. H. Meier, Research Engineer, Bucyrus-Erie Co.; L. E. Muller, Staff Engineer, Buick Motor Div., General Motors Corp.; A. R. Anderson, Consulting Engineer; and the Sperry Gyroscope Co.



RADIO SOCKET and switch bases are hot punched from Grade XXP and XXXP sheet. Phenolic laminates are chosen in electrical applications for their low power factor, low dielectric constant, low moisture absorption and high heat resistance.

Thermosetting Plastic Laminates—II

Various grades produced by combinations of fillers and resins were defined in Part I. Applications of thermosetting plastic laminates are based on physical, chemical and electrical properties. Advantages and limitations enable a working comparison of the laminate grades with each other, and with other materials.

NORMAN A. SKOW
Director of Research, Synthane Corporation

THERMOSETTING PLASTIC LAMINATES are not claimed to be "the best" in any one property. They are not as strong mechanically as steel, as good electrically as porcelain, as cheap as wood, as chemically-resistant as Teflon. However, it is their high "optimum" combination of these properties (see Table I, page 126, December 1948 PRODUCT ENGINEERING) that is outstanding. For example, if the designer needed the combination of high dielectric strength and impact resistance he could use one of the electrical-grade laminates, with only a slight sacrifice in the dielectric properties of porcelain and with much greater impact strength. In the following discussion, therefore, it should be remembered that specific laminate materials are chosen for a combination of properties, in addition to the principal functional use.

Electrical Applications

High structural strength, resistance to moisture and heat, excellent electrical properties, and easy machinability of laminated phenolics and melamines, account for their large volume use in all branches of the electrical industry.

The electrical properties for which these materials are valued include high dielectric strength, low power factor, and high insulation resistance. Where electrical insulation is the prime consideration, all standard dielectric tests are made transverse to laminations because the materials are usually stressed in this direction. However, if the voltage is applied to conductors passing transversely through the laminations, making the stresses parallel to the laminations, the dielectric strength is materially reduced. This is shown in the accompanying curves. Dielectric strength is also substantially reduced at elevated temperatures; this effect varies with the particular grade used.

The dielectric strength of any solid is raised to some power less than unity

as the thickness is increased:

$$KV = Ct^n$$

where

KV = dielectric strength
C = constant depending on kind of material
t = thickness
n = value between 0.5 and 1.0, depending on construction and type of material.

For phenolic laminates, the value of n is approximately 0.5, and the NEMA minimum standards ("Standards for Laminated Thermosetting Products", publication No. 46-118 of the National Electrical Manufacturers Association) agree closely with this formula.

Dielectric properties of plastic laminates are based on the ASTM "short time" and "step by step" tests. In the short time test, voltage is built up from zero at a rate of 500 volts per second until breakdown occurs. In the step by step method an initial voltage of 50 percent of the short time breakdown voltage is applied for one minute. A selected increment of increase is then applied, depending on the type of material, and the higher voltage is held for one minute at each step until breakdown occurs. Because of the time factor, the step by step test is more severe, and the values are lower.

Shown in Table II is the effect of temperature on the dielectric strength of thermosetting plastic laminates. As a general rule, when designing electrical apparatus that may have "hot-spot" temperatures of 100 C, a factor of safety of 4 should be allowed, taking the average values of 100 C as a base. Where the critical dielectric stresses are parallel to the laminations, Table II is of little value, and the application should be discussed with the laminate manufacturer.

Since volume resistance of these laminates is relatively high, it need not be given important consideration in the average application. Insulation resistance is more dependent on the condition of the surface than on the grade of material. For standard 3 x 2 x ½ in. samples with two 3/16 in. holes spaced one in. apart, the dry resistance between holes is above 200 megohms. Volume resistance and insulation resistance, when tested wet, are less for the fabric-base grades than for the paper-base grades.

Most organic insulators have poor resistance to arcing because the temperature of a sustained power arc will be above their charring point. With phenolics, this charring causes a highly conductive carbon path with resulting destructive action. There are, however, many applications such as distributor heads where the potential short-circuit current is small, and it is possible to use a coating of alkyd resin varnish, or a face sheet treated with a melamine resin. Vulcanized fibre is also used as a face sheet for improved arc resistance. However, where arcing is a serious problem, melamine laminates are recommended. Grade G-5, continuous filament glass cloth bonded with melamine resin, has the highest arc resistance of all commercially available thermosetting laminates. The following test results (ASTM Method D495-48T) illustrate the difference in arc resistance between phenolic and melamine laminates:

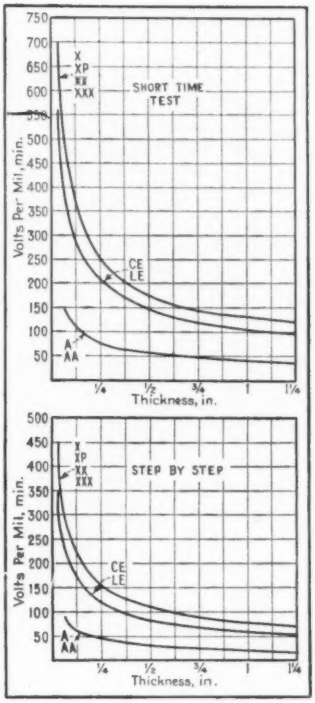
Grade (Material)	Arc Resistance, seconds
G-1 (glass-base phenolic)	20–30
XXM (paper-base melamine)	80–120
AAM (asbestos-base melamine)	130–160
G-3 (phenolic-continuous filament glass cloth)	20–30
G-5 (melamine-continuous filament glass cloth)	180–190

In electronic circuits, low losses and power-factor stability are the vital factors. All insulators become less effective at ultra-high frequencies. In addition, the power available may be so little that even a very low loss may keep an oscillator circuit from functioning. It is also necessary with these ultra-high frequency circuits to guard against "corona". Conductors in contact with the material must have no sharp points from which corona might start and they should also fit snugly if mounted in holes.

In general, the following laminate grades are used most commonly for radio applications (for compositions, see Part I, pp. 125-126, December 1948 PRODUCT ENGINEERING):

XP, sheet—Sockets, terminal boards, miscellaneous instrument parts where insulating properties and moisture resistance are of minor importance and good punching and assembling characteristics essential.

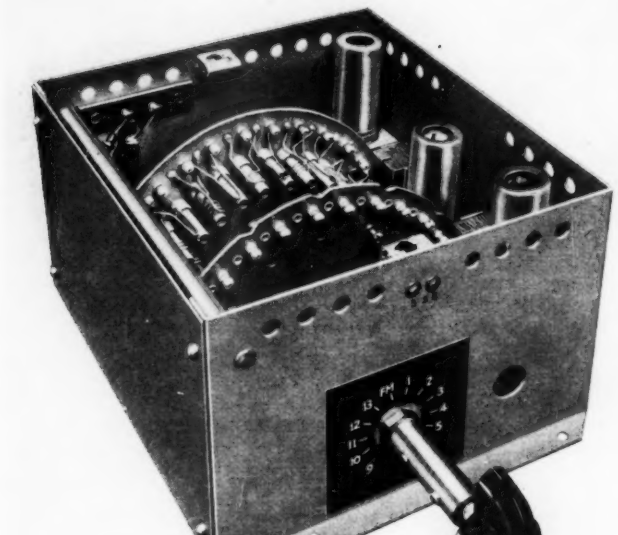
X, rolled tube—Coil forms in receiving sets and other applications where good punching characteristics are essential and where the insulating



DIELECTRIC STRENGTH of laminate sheet grades varies with thickness. Tests are made perpendicular to laminations, according to ASTM D229-46.

Table II—Effect of Temperature on Electrical Properties

NEMA Grade	Dielectric Strength (volts per mil) perpendicular to laminations (thickness, 1/16 in.)			
	Short Time		Step by Step	
	25C	100C	25C	100C
X	700	600	500	250
XX	700	500	500	300
XXX	650	500	450	350
XP	700	400	500	250
XXP	700	645	500	430
XXXP	650	500	450	400
C	200	160	120	110
CE	500	350	300	290
L	200	130	120	75
LE	500	320	300	200
A	225	100	135	85
AA	50	40	30	20
G-1	550	520	410	405
G-5	500	450	350	300



EXCELLENT DIMENSIONAL STABILITY, mechanical strength, low power factor and high dielectric strength required in this television channel selector led to the choice of thermosetting laminate materials. Two rotating switching disks are punched to shape from Grade XXXP sheet, and terminal strip at rear from Grade XX sheet.

properties under moist conditions need not be quite as good as Grade XX.

XX, rolled tube—General use in transmitting coil forms and in radio frequency apparatus where low losses are essential even under humid conditions.

XXP, sheet—General use for insulation in radio frequency circuits where punching and assembling operations are not particularly severe.

XXXP, sheet—Punched parts where very low losses are essential, such as variable capacitor insulation, metal tube insulation and some range switch parts. Replaces porcelain radio parts; will take eyelet operation and can be machined.

XXX, sheet—General use in instruments and other machined parts, where reasonably good appearance and good electrical properties are desired.

CE, sheet—Applications similar to XXP sheet, except for more severe assembling operations.

There is a relationship between good electrical properties and low moisture absorption. The grades that exhibit the lowest water absorption are most resistant to changes in electrical properties when exposed to moisture (see Table III). This accounts for the excellent electrical properties of Grade XXXP: Short time dielectric strength of 650 volts per mil and power factor of 0.027, which is the lowest for all grades except glass and nylon. Grade XXXP and the glass and nylon grades are most suitable for high voltage applications; the non-electrical fabric grades (C and L) are suitable for only the lower voltages; with the other paper and fabric grades ranging in between.

Thermosetting plastic laminates are used extensively in telephone equipment because of their non-hygroscopic characteristics and ability to maintain good insulating properties under varied climatic conditions. Their ability to withstand cold flow under the pressure of retaining screws or mountings makes them especially useful in plastic-to-metal assemblies such as are found in automatic telephone systems; the "live terminal banks" for selector and connector switches consist of numerous assemblies of brass strips separated and insulated by these materials.

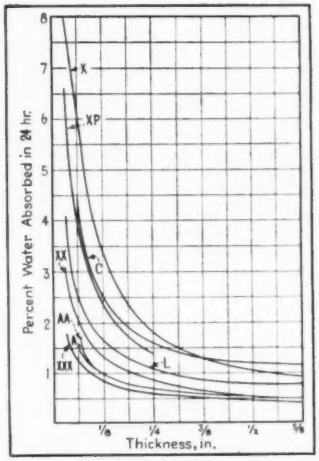
Other applications of thermosetting plastic laminates include insulation for electrical power equipment, and insulation and mechanical parts for every type of electrical appliance.

Moisture and Chemical Resistance

Thermosetting plastic laminates are practically unaffected by water, ordinary solvents and oils. For this reason, they are used widely in the chemical and textile industries.

Phenolic laminates are not attacked by the common solvents such as alcohol, ether, or the petroleum products, and resist low concentrations of the mineral acids except nitric and chromic. They offer excellent resistance to the fruit acids: Acetic, maleic, citric, ethyl lactate; but are attacked by the oxidizing acids, particularly at higher concentrations and elevated temperatures. They are also attacked by the alkalis, especially sodium hydroxide. However, they often retain their strength in spite of chemical attack and therefore may have a long useful life. As an illustration, rayon spinning buckets have an average life of at least four years with almost constant exposure to a solution containing 15 percent sulfuric acid, while operating at a peripheral speed of 20,000 fpm, and with the added stress of the load carried.

Melamine laminates show superior resistance to alkaline solutions. However, the corrosion resistance of any material is usually relative. The extent to which any material is resistant depends generally on a combination of factors—the nature, concentration, and temperature of the chemical or corrosive agent, the time of exposure, the degree of agitation, and the moisture



MOISTURE ABSORPTION of thermosetting plastic laminate sheets varies with thickness, and shows a characteristic curve for each grade.

absorption and chemical reactivity of the material itself.

For example, 10 percent solutions of either sulfuric acid or potasium dichromate have little effect on thermosetting plastic laminates. But if the two are mixed in the presence of organic matter a vigorous oxidizing action occurs which will destroy almost any synthetic resin. A 20 percent concentration of sulfuric acid alone, which would only slightly affect Grade C at 75 F will decompose it rapidly when the temperature is elevated to 180 F.

In general, the laminates are indicated for applications requiring resistance to chemicals under the following conditions:

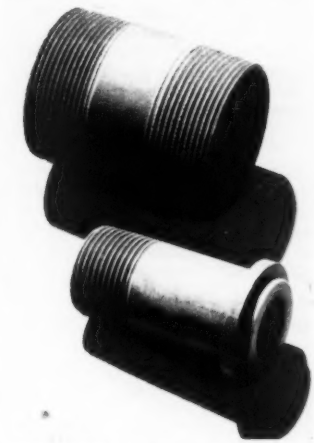
1. Where material must withstand high tensile stresses.
2. Where easy fabrication of laminates reduces cost of replacements.
3. Where retention of strength gives a more useful life at a lower cost than other materials even though replacement is frequent.
4. Where good dielectric properties are also a factor.

Where corrosion-resistance is important, selection of the base material must be made with care, since it is usually the base rather than the resin that is first affected. For the manufacture of corrosion-resisting laminates, cotton fabric, asbestos paper or fabric, and glass fabric have their special values as base materials. Cotton is satisfactory for weak acids, weak bases and low concentrations of salts, or neutral salts in any concentration. Asbestos is used for strong alkaline conditions or highly concentrated salt solutions which tend to hydrolyze or split into alkaline radicals. Asbestos is not recommended for acid salts even in low concentrations. Glass cloth base is recommended for strong concentrations of acids or acid salts. Paper-base laminates are not satisfactory for most chemical applications.

For the optimum combination of chemical resistance, economy, and mechanical strength, the fabric-base phenolics (C and L) are usually superior to other grades. Any concentration and temperature up to 180 F of the salts of the following metals will not affect these grades, except to produce a slight change in color: Aluminum, barium, bismuth, cadmium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, silver, tin, zinc, calcium, (except hypochlorite), potassium (except hydroxide), sodium (except hydroxide and hypochlorite). These grades will also resist the following solvents: Aliphatic hydrocarbons; aromatic hydrocarbons (except those which have hydrolyzed; for example, carbon tetrachloride in the presence of moisture). These grades will *not* resist: Chlorine gas, wet or dry; sodium hypochlorite; chlorine water; sodium hydroxide; potassium hydroxide; calcium hypochlorite; bromine and bromine water; pyridine. They will resist the following acids at room temperature: Acetic; benzoic conc.; boric conc.; phenol; chromic (special

Table III—Effect of Moisture on Electrical Properties

NEMA Grade	Power Factor, 10^6 cycles (thickness, 1/16 in.)		Dielectric Constant, 10^6 cycles (thickness, 1/16 in.)	
	As Received	After 24 hr in Water	As Received	After 24 hr in Water
X	0.060	0.080	6.0	7.0
XX	0.040	0.046	5.0	5.4
XXX	0.032	0.038	4.8	5.0
XP	0.060	0.075	6.0	6.8
XXP	0.040	0.045	5.0	5.2
XXXP	0.027	0.030	4.5	4.8
C	0.10	0.20	7.0	9.0
CE	0.055	0.065	5.5	5.6
L	0.10	0.146	7.0	8.2
LE	0.045	0.050	5.0	5.5
A	0.20	0.25	7.0	7.3
AA	0.590	0.730	7.5	12.5
G-1	0.017	0.150	4.8	6.8
G-5	0.011	0.089	6.1	7.9



PIPE NIPPLE (top) and gas meter coupling, machined from Grade C tubing, prevent transmission of electrolytic currents in domestic gas meters.

PERFORATED PLATING BARREL, formed of Grade C laminated phenolic sheets and tube sections, resists corrosion from a variety of plating solutions, and erosion from tumbling pieces. The plastic laminate also provides electrical insulation, and resistance to abrasion and bearing pressure.

MECHANICAL PARTS are made from thermosetting plastic laminates for a wide variety of uses: A, V-belt pulley is machined from a molded—macerated Grade C blank, chosen for excellent wear resistance and lightweight. B, closing cam for a domestic pressure cooker lid is machined from glossy black Grade XX sheet, which is dimensionally stable in hot and corrosive atmosphere. C, ratchet is machined from Grade L material containing graphite; no lubrication is required.

resin required; intermittent exposure as in plating); citric conc.; formic conc.; hydrochloric; hydrofluoric; lactic conc.; nitric; oxalic conc.; phosphoric; sulfuric; sulfurous. The addition of salts such as 20 percent sodium sulphate to 10 percent sulfuric acid is known to inhibit the effect of the acid for a long period of time.

For carrying of certain chemical solutions, laminate tubing is used: Phenolic for acid solutions, and melamine for alkaline solutions. In the chemical industry, molded-laminated fittings, such as elbows, tees, flanges, couplings and plug cocks are available in many sizes, for erection of chemical pipe lines. Other chemical applications of these laminates include rayon bucket covers, film developing equipment, drying trays, distributors, tank linings, agitators, gears and plating barrels. In plating barrels, for acid solutions, Grade L has proved excellent, because of its superior machinability. For alkaline solutions, the melamine Grade LM is used.

Thermal Properties

It can be seen from Table IV that elevated temperature does not cause a large negative qualitative change in mechanical properties of the thermosetting plastic laminate. Impact strength is, in fact, improved.

An outstanding property of the thermosetting plastic laminates is their low coefficient of thermal expansion which ranges from 0.00002 to 0.00003 in./in./C. This makes them a "natural" material for housings and spacing insulators, to fulfill a combination of bearing strength or other mechanical property, and heat insulation.

Cotton fabric-base laminates can be used continuously at 100 C and for short time exposure at 150 C. Paper-base laminates can be used continuously at 120 C and for short time exposures at 160 C. Asbestos, paper or woven-fabric grades and glass-fabric grades, can be used continuously at 120 C and for short time exposure at 200 C. This is only a rough rule because the effect of elevated temperatures varies with the application. All grades tend to soften somewhat at temperatures above 150 C, and if exposed to mechanical stresses, may be deformed at lower temperatures than those suggested. Conversely, if the material is supported, such as an insulator between metal plates, it can withstand much higher temperatures.

Thermosetting plastic laminates are used successfully in live steam, but the temperatures suggested for paper-base materials should be reduced by 20 percent. The woven-fabric laminates, because of the "organization" caused by weaving, do not disintegrate even after attack by heat or by chemicals.

Dielectric strength, insulation resistance, power factor and electrical losses are all adversely affected as temperature is increased. Step by step dielectric strength tests after subjection to 150 C (tested at 25 C) give the following results: All grades show a marked increase after the first several days; the values then begin to drop, and after 20 days, Grades C and XX are about half of the original values, Grades A and G-3 are only slightly lower, Grades LE and AA are higher.

It is possible to increase the dimensional stability of most grades by a long annealing treatment at a temperature higher than the temperature to which the material is to be exposed. If carried out at extreme temperatures, the material will tend to become more brittle. All properties except tensile strength show an improvement after 24 to 96 hr. This is caused by relieving of strains and the freeing of last traces of volatile matter. When material is required to operate at temperatures above 100 C, the requirement should be specified on the order.

The recent development of silicone-glass laminates has opened new fields for designers of electrical insulation and mechanical parts subject to high temperature operation. An outstanding feature of these new laminates is their ability to withstand prolonged exposure to temperatures as high as 250 C. Tests conducted on the material showed that its properties improved constantly during a full week at 250 C. Silicone glass laminates will not propagate fire and the products of combustion induced by a constantly applied flame are low in toxic gases such as carbon monoxide. Their fabrication offers no more difficulty than the melamine-glass laminates.

Mechanical Applications

Fabric-base grades are chosen where severe shock loads, repeated bending stresses, resistance to wear, and easy machineability are vital properties. The fabric-base grades are considered tougher than the paper-base grades.

Table IV—Effect of Temperature on Mechanical Properties (Grade C Sheet)

	−70 F	77 F	160 F
Flexural Strength, psi	25,000	21,000	16,000
Modulus of Elasticity, psi	1,400,000	1,100,000	700,000
Tensile Strength, psi	.....	11,000	9,000
Compressive Strength, psi	.....	23,000	18,000
Shear Strength, psi	.....	13,000	11,000
Impact Strength, Izod, ft-lb per in. of notch	2.7	4.5	5.6

Courtesy Prof. Ralph K. Witt, NEMA—Johns Hopkins Plastics Project

The mechanical fabric-base grades are also tougher than the electrical fabric-base grades. Because the linen grades are made with finer weave fabrics, the texture is finer and lends itself to machining into more intricate shapes. For gears, this permits teeth of finer pitch.

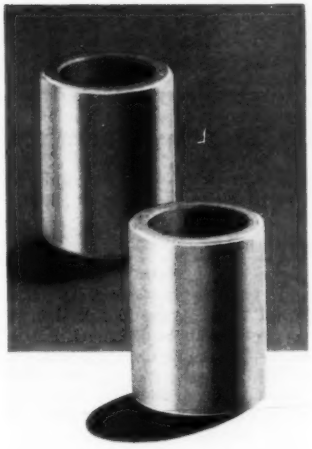
Thermosetting plastic laminates have an unusual combination of properties desirable in gears. One of the results of this combination is the reduction of gear operating noise. The clatter and vibration customary with metal-to-metal contact are virtually eliminated. The laminates markedly decrease the "telegraphing" of noises for which metal gears are known. Light in weight—about half the weight of aluminum, one-sixth the weight of steel—their low moment of inertia make laminate gears easy to start and stop, a factor of importance in high speed machines that are frequently interrupted.

Two grades are generally used, Grade C and Grade L. Grade C is strong, tough, and well suited for all except very fine pitch gears because of its high impact strength. Grade L is preferred for small gears having fine pitch and narrow face. Grade L is not as tough as Grade C but machines cleanly and accurately. These grades are furnished in the form of sheets or gear blanks bandsawed to size. Teeth can be readily and quickly cut with the same standard cutters and machines used for metallic gears—milling machines with indexing heads, single cutter automatic milling machines, hobbing machines and gear shapers.

Although a general table of properties is given in Part I of this article—page 126, December 1948 PRODUCT ENGINEERING—a review of the physical properties of Grades C and L is in order:

Property	Grade C	Grade L
Tensile strength, psi	9,500	9,000
Flexural (Transverse) strength, psi	20,000	20,000
Compressive strength, psi	38,000	35,000
Rockwell Hardness	M-110	M-110
Moisture Absorption, ASTM Test Method, percent	1.7	1.4
Specific gravity	1.35	1.35
Weight	20 cu in. per lb	

Gears cut from these materials are used in a variety of applications, including heavy duty gears for mine hoists and steam shovels, average duty gears for lathes, screw machines, automobile timing gears, gear motors, washing and ironing machines, and the light applications such as hair clippers, fruit juice extractors, accounting machines, phonographs and clocks.



FOOD MIXER brushholder bushings are machined from Grade XX tubing on an automatic screw machine to dimensions of 37/64 in. long, 0.313 in. ID and 0.437 in. OD. Laminate is used because of superior mechanical and electrical properties.

LAMINATED PHENOLIC separators prevent nylon yarn "balloons" from entangling each other when being wound on bobbins. Smooth, hard surface of the paper-base Grade X laminate is resistant to wear, and does not snag the yarn.

Laminated cam blanks are hard and dense, yet nonmetallic and easy to machine. These blanks make short runs practical because they are so quickly cut and finished. In service, best results are obtained when pressures are light; when properly used they have long life.

Grades containing graphite can be obtained. These anti-friction grades are more suitable than standard grades for bearings and similar applications. They are available in sheets, rods, tubes and special shapes.

The glass-base grades, in addition to their good heat resistance, have high tensile and impact strength and extremely high impact fatigue, which is important where structural parts are subjected to repeated stressing.

Laminated plastics are often chosen in preference to metals and other materials. When exposed to humid conditions, all grades show some consequent dimensional change. However, their dimensional stability is superior to other nonmetallic structural materials. Their high resiliency makes it possible to obtain press fits with wider tolerances than are required of steel. For the best dimensional stability there are special grades, having high resin content and other modifications, in which moisture absorption has been reduced to a minimum. Because of low specific gravity—one-half that of aluminum and three quarters that of magnesium—specific strength of these laminates is high. In aircraft and other applications involving high rotational speeds, their light weight reduces start-and-stop inertia. Chemical processing equipment makes use of laminates because of their resistance to corrosion; most metals have low resistance to chemical attack.

The combination of properties most useful in textile applications are corrosion resistance, light weight, smoothness, resilience, high strength and dimensional stability. For this reason, Grades XX and C are most often used. The structural strength of laminate tubing and its dimensional stability in high humidity form an important combination in the manufacture and maintenance of textile machinery parts.

Grade C paper base tubing is used for bobbins and barrels in contact with delicate fibers of cotton silk or rayon. The corrosion resistance of this tubing is an important characteristic in parts used in the production of rayon and synthetic yarns. Typical application of these materials in the textile industry include guide strips and arms, roll tires and covers, stocking examiner forms, twister balloon separators, verge strips, rayon processing equipment and welt rods.

EDITOR'S NOTE: The next article in this series, to appear in a forthcoming issue of PRODUCT ENGINEERING, will discuss design data, available shapes and fabricating methods.

Analyzing Relay Characteristics

From "Analyzing Relay Characteristics" by E. R. Morton, *Bell Laboratories Record*, July, 1948.

MANY METHODS of analysis have been devised to make it easier to predict the behavior and discover the limitations of relays. Curves are available for various relay structures showing the relationship between air gap and pull for various ampere turns. By comparing these curves with any desired load characteristics, the required winding may be determined.

In designing new relays, however, or in attempting to improve existing ones, a more elaborate analysis is sometimes required. For this purpose, a convenient graphical method has been devised. It consists of a set of curves that show the relationship between pull and air gap for an ideal relay—that is, one whose entire magnetizing force is available at the air gap—for different ampere turns.

A schematic illustration of a relay is shown in Fig. 1. Current flowing in the winding tends to move the armature and close the air gap with a force proportional to the area of the air gap and the square of the flux density. The pull may be expressed as:

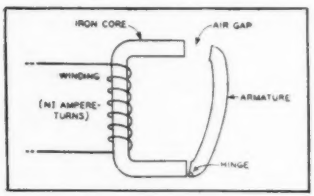


Fig. 1—Components of a typical relay.

$$p = k_1 A\beta^2 \qquad (1)$$

where β is the flux density in the air gap, and A is the area of the air gap.

The magnetizing force in ampere turns to produce a given flux density is directly proportional to the product of the flux density and the length of the magnetic path, and inversely proportional to the permeability of the material. The ampere-turns may thus be expressed as:

$$NI = k_2 L\beta/\mu \qquad (2)$$

Since the magnetic circuit of a relay consists of two materials, each with different values of permeability, the total ampere-turns may be divided into two parts: one for the air gap with a permeability of one, and the other for the iron. For the air gap,

$$NI_A = k_2 L_A\beta \qquad (3)$$

for the iron

$$NI_M = k_2 L_M\beta/\mu \qquad (4)$$

where L_A is the length of air gap, and L_M, the length of the iron path. It is the former part of the ampere-turns that is directly useful in producing a pull on the armature, and for ordinary conditions it is much greater than that for the iron path. An ideal relay would be one for which all the ampere-turns were effective in producing air gap flux, and the relationship between pull and ampere-turns for such a relay may be determined by solving Equation 3 for β, and then substituting this value of β into Eq. 1. This gives:

$$p/A = k_3 (NI)^2 / L_A^2 \qquad (5)$$

which expresses the pull per unit of pole area for each value of ampere-turns and length of air gap. If the pull is expressed in grams, the length of the air gap in cm and the area of the air gap in sq cm, the constant k_3 is 6.4×10^{-3}. This relationship plotted on logarithmic paper for different values of ampere-turns becomes a series of straight lines, as shown in Fig. 2 for current densities of 10, 100, 400, and 1000 ampere turns. To simplify the drawing of curves for other values of ampere-turns as they are needed, dashed vertical lines are drawn at values for p/A of 64 and 6,400. With these values substituted into Eq 5, the air gap is one-thousandth and one-ten-thousandth, respectively, of the ampere-turns. A curve for 200 ampere-turns, for example, would be a straight line between the point where the p/A equals 64 line intersects the line for a gap of 0.2 cm and that where the line for p/A equals 6,400 intersects the gap for 0.02 centimeters.

Such curves represent the operation of an ideal relay; the curve for any actual relay will be lower because of the three losses. One of these is due to the ampere turns required to force flux through the iron path of the circuit. Another is due to the existence at the hinge of a small air gap that is not usable in producing pull. The third is due to leakage flux that tends to saturate the core without passing through the air gap.

The length of air gap lost because of the ampere turns required to force the air gap flux through the iron path is found, by equating Eqs 3-4, to be

$$L_A = L_M/\mu$$

In other words, the length of the iron path divided by the permeability of the iron gives the length of the air gap that is equivalent to a core L_M cm

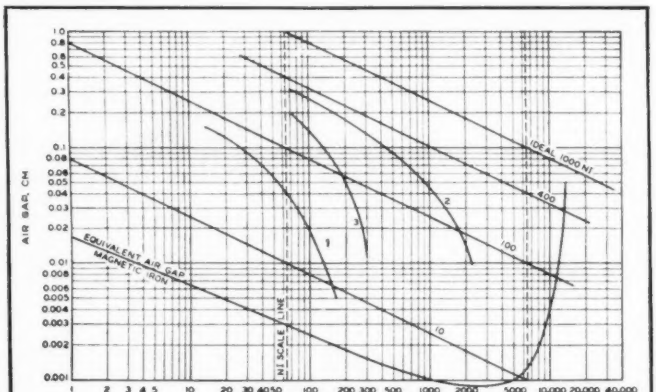


Fig. 2—Relationships between size of air gap and pull for different valves of ampere turns for an ideal relay. By then plotting the measured pull of an actual relay, the hinge and leakage losses can be determined, and operating characteristics studied.

long. The magnetization curve for the particular iron gives the value of permeability for each value of flux density, and thus the air gap equivalent to the iron path for each value of flux density may be determined.

By Eq 1., however, there is one value of pull corresponding to each value of flux density. Thus it is possible to draw a curve on Fig. 2 that represents for any particular magnetic material and length of path, the equivalent air gap lost because of the number of ampere turns (NI) required to force the air-gap flux through the iron. Such an equivalent air-gap curve has been drawn on Fig. 2 for one particular material and for a length of path of 10 cm. It is now possible to use Fig. 2 for a complete graphical analysis of a relay that has a 10-cm constant-area iron path of the material for which the equivalent curve was drawn.

The first step is to run a test on the relay at some low value of ampere turns and to plot the data on Fig. 2. Such a curve for 100 *NI* is marked No. 1 on Fig. 2. By subtracting the values of air-gap for this curve from those for the ideal 100 *NI* curve, the total loss in effective air gap is found, and by subtracting from these values the values from the equivalent air-gap curve for the core, there remains the loss due to hinge gap. Carrying out these subtractions gives a gap of about 0.055 cm for all values of pull. The fact that these differences are constant indicates that no appreciable leakage is present, since the leakage effect would tend to increase with flux density. It may be assumed, therefore, that for this relay the hinge gap is 0.055 cm.

To study the behavior of the relay at some higher magnetizing force, say 400 *NI*, the 0.005 cm hinge gap is added to the gaps for the iron core; by subtracting these sums from the ideal 400 *NI* line, Curve 2 may be plotted. This would represent the operating curve of the relay for 400 *NI* if there were no leakage. By running a test on the relay for 400 *NI*, the actual characteristics can be determined and plotted. Such a curve is marked No. 3 on the chart. Comparing Curves 2 and 3 shows an additional loss due to leakage. If there were no leakage, a pull of 2,000 grams could be obtained at a gap of 0.01 cm, but with the actual relay, the maximum pull is only about 300 grams.

Leakage flux, which varies with the existing ampere turns, is present at all times, but only when the sum of the leakage and air gap flux is great enough to result in a decreasing permeability does it reduce the pull. If the air gap flux were the only flux, saturation would not begin until after the pull were greater than 3,000 grams, since as may be seen from the equivalent air-gap curve, maximum permeability occurs at a flux density that corresponds to this pull. When saturation effects are pronounced at pulls as low as 300 grams, as for the relay yielding Curve 3, it is evident that there must be a large leakage flux—large enough to increase the total flux from that corresponding to 300 grams to that corresponding to well above 3,000 grams, where the equivalent air-gap curve begins to rise.

One advantage of this type of chart is that it makes such situations evident at a glance. In addition it enables both hinge loss and leakage loss to be determined, and thus permits the behavior of the relay to be predicted for any conditions. The information it yields also indicates the type of changes that should be made in the relay structure to secure other characteristics. For new designs, it reveals characteristics a relay structure should have to meet.

Some Crack Detection Methods

Foreign abstract condensed from "Some Crack Detection Methods" by Horace Manley, *Metallurgia*, July, 1948, p 165-168.

TO DETECT INTERNAL FLAWS there are two techniques commercially available: radiography and ultrasonics. The latter, which is more sensitive of the two, will not detect surface and near surface cracks with equipment used at present. Of the variety of methods for surface crack detection, only two are satisfactory. The others are inconsistent and unreliable or quite insensitive.

The most desirable non-destructive testing equipment would either detect faults above a pre-set minimum size, or clearly show, or allow judgment on, faults too small to be of importance on the job at hand. The idea of tolerances is difficult to apply in crack detection, but it can be brought into some of the methods, the fluorescent for example, to give a rough equivalent of a "go" and "no-go" gage.

The magnetic method applies to all alloys that can be magnetized by induction. The pattern of fine iron dust spread over the magnetized metal gives rise to free magnetic poles on either side of the gap caused by a crack. The method is most sensitive to cracks perpendicular to the magnetic field. To detect parallel faults the specimen must be magnetized as nearly as possible at right angles to the first test.

The method normally used is to pour liquid over the metal surface while the electric current is passing through a surrounding coil. German "Periflux" apparatus uses very pure carbonyl iron powder in oil. An added degree of flexibility can be obtained by using alternating current which travels on the surface skin of the metal and detects surface cracks, whereas direct current will also show up cracks as much as $\frac{1}{4}$ in. below the surface.

A recent development whose problems and advantages are not fully known is the Russian method for obtaining permanent records. A rapid drying collodian liquid is used with crocus powder suspended in it. When this film is pulled off, a permanent record can be kept if desired. It is believed that the American "Magnaglo" combines the advantage of this and the fluorescent technique.

There are many old and simple techniques relying on the fact that recleaning the surface will normally still leave crevices filled with a paste or solution which will then be visually obvious because of some dye or coloring substance in the liquid. French chalk in paraffin oil, red lead and acid-etch techniques are all used for large cracks. The acid-etch is particularly good since it provides its own matte surface as a good contrast, but it cannot be used on finished products. At the best, these methods will detect only large cracks and are rather crude and generally unsatisfactory.

The fluorescent technique is an improvement of this idea. When the surface is dry, the fluorescent chemical liquid still in the crack tends to bulge over the surface because of surface tension and similar effects. Under ultra-violet light quite small cracks can be seen to glint and flash. For quantitative determination there is the interesting possibility of arranging limits for crack size detected by setting the work at a definite distance from the observer.

For surface flaws, two electrical methods, applicable to non-magnetic

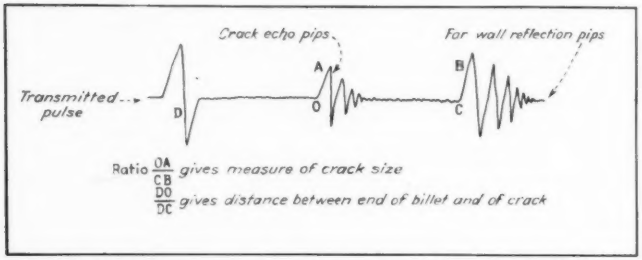


Fig. 1—Showing the appearance of sound waves affected by a crack as picked up on ultrasonic viewer screen.

materials have been applied. The eddy current technique is more complicated, less direct and not so satisfactory as the magnetic method for steels. The basic idea is to listen through earphones to the change in the note of an electrical oscillating circuit used as an inductance coil approaching the surface of the specimen. The change in note is caused by the eddy current inducted into the metal by the coil. Distortion of the note is a measure of the soundness of the specimen. Method at present is insensitive, since a small change in pitch in a high frequency note is not readily noticed by the human ear. However, the technique can be improved. It certainly has the advantage that it can be applied to most alloys.

The direct resistance method does not seem likely to become highly sensitive, since the extra resistance caused by a small crack is not readily detectable and the surface must be well polished.

Radiographic and ultrasonic technique cannot be easily used by non-technical personnel. Skill is needed to interpret the results and an understanding of modern physics to keep the apparatus working. Radiographic technique is good but expensive. It is invaluable for the inspection of welds and checking of new types of castings and forgings. High voltage X-ray sets weigh up to two tons complete with accessories. They are quite mobile.

Gamma rays are sometimes used. They need a long exposure time to the source. The use of a fluorescent screen enables a great speeding up and is ideal for continuous inspection where it can be arranged.

The use of ultrasonics for internal fault finding is continuously increasing. The equipment is not very expensive, and only a little more complicated than a cathode-ray tube. Ultrasonics are sound waves of such high frequency that they are inaudible to humans. They are readily transmitted by metals and liquids, but also easily reflected at air-to-metal surfaces. A beam is reflected by a very thin air film, and cracks can be detected 100 times as fine as by radiography.

A radar pulse of oscillations, when sent out by the piezo electric oscillator, is transmitted into the ingot. The pulse is reflected from the far end of the ingot and picked up by the received, which is also a piezo electric crystal placed quite close to the transmitter. If there are any cracks in the path, they will reflect part of the beam. These reflected waves, having less distance to travel, reach the receiver before those from the far end.

Fig. 1 shows how these pulses are observed on a cathode-ray tube. By determining the echo-pip with the transmitter at two different places on the ingot surface, the cracked position can be located to within a quarter inch inside a 12 ft ingot. The frequency used varies from 1 to 5 mcs depending on the metal, ingot length, and type of flaw. Faults within a half inch or so of the surface cannot be detected because the echo pip is continuous with the transmitted pulse. If necessary, porosity and crack faults may be distinguished by varying the frequency in billets less than an inch thick. This is useful in porous metal such as self-oiling bearings.

There are at least two methods suitable for continuous inspection of strip. The Germans used a very good magnetostriction oscillator arrangement for lamination detection during the war. The ultrasonics beam is sent through the metal, using running water as a contact, and detected by a suspension of aluminum powder in Xylol contained in a transparent plastic trough. With strong illumination the laminations are seen in the powder pattern. Normally all the small aluminum flakes set themselves parallel to the ultrasonic beam. Where the beam has been reflected by a lamination fault the particles are randomly oriented and easily seen as a pattern against their neighbors which are all set in one direction, perpendicular to the beam.

An earlier method used in the United States was a piezo electricoscillator modulated at 100 cycles so that it was audible in a pair of ear phones and the faults were noticeable by a change in note or using a discharge lamp with a trip relay circuit. There was also a method of marking one side of the strip parallel to the lamination automatically as it was detected.

Fillers for Low Pressure Laminates

From "Low Pressure Laminating Fillers and Their Properties", by Leonard S. Meyer, Western Products, Inc., presented at Low Pressure Seminar of the Society of Plastics Industry, June 29-30, 1948, Washington, D. C.

A COMBINATION of filler plus resin is stronger than either material alone. Radical differences in physical properties result when different fillers are used with any one resin. Since the cost of available fillers varies widely, it is sometimes difficult to decide on one for a particular application.

Fig. 1 is an attempt to simplify some of the basic cost-strength factors affecting filler choice: Upper right—relative costs of materials based on current filler costs and the amount of a 35 cents per lb resin each filler will take up; upper left—relative strengths of these laminates expressed as specific flexural strength, which is considered the most important strength property of the laminate. Impact strength is considered next in importance and particularly affects paper laminates; lower left—relative strengths obtained per dollar spent for materials; lower right—typical applications of each filler, taking into account these factors.

Ability to fail "properly" under load. Glass and certain cotton fabrics are used to produce wing liner and integral fuel cells, in which the laminate protects and supports a self-sealing rubber liner after penetration by gunfire. The material is not expected to stop penetration but is expected to confine the failure to a local hole without shattering, splitting, or bulging.

Decorative uses. Paper and fabrics are used as pigment carriers in order to produce colored laminates. Likewise

they are printed to produce flat sheet laminates and shaped parts.

Transparency. Certain fillers such as rayon, special glass fabrics, and highly refined cellulose have indexes of refraction close enough to the resins used so that, in thin sections, they are practically transparent. These materials are useful as overlay films for decorative flat sheet laminates and as bulk fillers to produce translucent laminates.

Heat resistance. Glass mat or fabric and certain kinds of asbestos are used wherever high temperatures must be met. Electric motor slot insulation and aircraft hot air ducts are typical uses.

Dimensional stability. Although wide variations can be obtained by resin changes with any one filler, glass fabric is the outstanding filler for dimensionally stable laminates. An example is a photo template sheet made from glass fabric.

Electrical characteristics. Electrical characteristics of low pressure laminates are dependent to a larger extent on the resin rather than the filler. Glass and iron free asbestos are outstanding materials for electrical purposes, where heat and humidity are allied problems. Heavy duty motor slot insulation and radomes are examples.

Drawing characteristics. Occasionally certain applications of low pressure laminates are simple enough in shape so that economies can be realized by producing flat sheet and then postforming into more intricate shapes. Specially woven cotton fabric is the filler most often used.

Preforming fillers. Many shaped laminates can be produced by flotation of fillers, in the form of threads or strands, in air which is then sucked through a porous mold of proper shape. The filler is deposited on the porous mold and a mat is produced in shape, thickness, and weight ready for resin application. Dry resin can be added during this process, resin solutions can be used to impregnate such a preformed filler, or the preform is placed in the curing mold and liquid resin pumped into the filler. This method of preforming fillers offers low cost and uniform physical properties of a mat without the danger of fiber displacement when forming from flat webs.

Nylon. Nylon fabric is one of the newer fillers to be used for laminates. Its cost is high but products made show outstanding electrical properties and impact resistance. Electrical panels and flak armor are under consideration.

Perforated papers. When pressures available are low, liquid resins such as polyesters are desirable. While paper fillers are adequate strengthwise, it is difficult to produce paper laminates without entrapment of air between plies. Any air or other gases present during cure will produce a poor product. To facilitate gas removal during cure of paper laminates, the paper can be perforated electrically by means of high voltage discharge. This method of perforation is adaptable to quantity production so that costs are not prohibitive. The small holes do not materially reduce strength.

Fiber surface treatments. One of the important new developments concerning fillers for low pressure laminates is the ability to treat material so that a particular resin will really wet individual fibers. This chemical treatment of filler promises to bridge the wide gap between theoretical laminate strengths based on individual fiber strength and actual values obtained.

Significant filler treatments available today are: (a) Heat cleaning of glass until fiber is chemically clean; (b) three chemical surface treatments of glass fiber which produce superior results with three separate resin types; (c) cleaning and desizing of cotton fabrics; (d) two chemical surface treatments for cotton fiber, one of which reduces water absorption and the other functioning as a mildew preventive with an additional advantage of improving electrical properties; (e) chemical surface treatment (urea formaldehyde) of cellulose in paper is being checked in production quantities.

Glass paper. Although paper has not been made from 100 percent glass fiber, combinations of glass and cellulose fibers can be made into paper that bridges the gap in properties between paper and glass mat.

Pigmentation of cotton. Cotton fabric can be purchased already colored with pigments that have been tested and proven for use with newer resins such Cotton mats. Cotton mats are under extensive development and should become useful fillers. They will eliminate the weaving of fabrics and still retain the low fiber density of cotton.

Synchrolating. This treatment of cotton fabrics produces up to 30 percent allowable stretch and is useful for drawing operations.

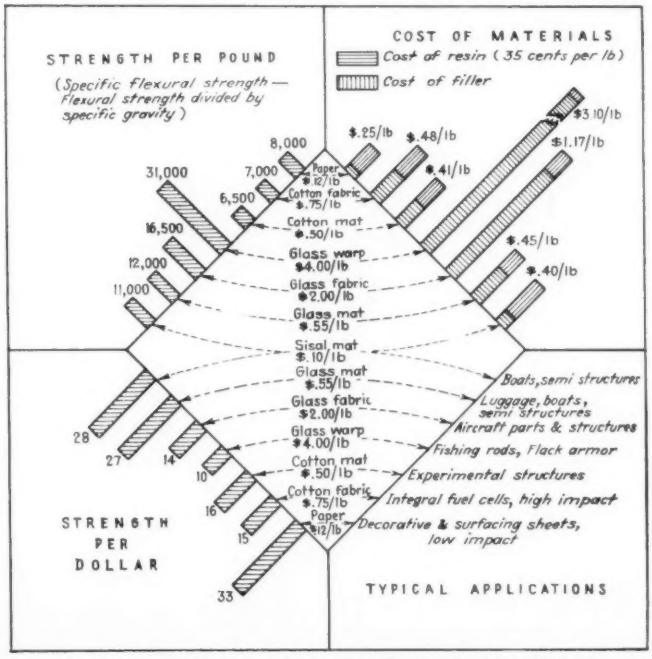
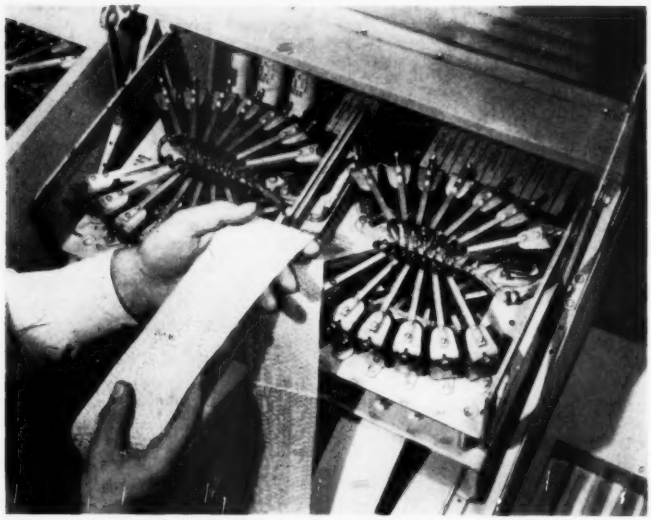


Fig. 1—Strength-Cost Comparisons of Low Pressure Laminating Fillers.

TECHNICAL NEWS



TAPE-PUNCHING EQUIPMENT records calling and called telephone numbers on ⅜ in.-wide tape. Data are then sorted and toll charges computed preparatory to billing.

New System Computes Telephone Charges

A HUGE "ELECTRICAL BRAIN" that records all dial telephone calls through a telephone central, sorts them out and then computes the bill of each telephone subscriber was recently demonstrated by Bell Telephone Laboratories. Called Automatic Message Accounting, the system has been in operation since July on the telephones in Media, Pa., a Philadelphia suburb. Sorting and computing machines are centered in downtown Philadelphia.

By reducing the multitude of meters and human computations that now monitor the price of dial telephone service, the new system will make for more accurate telephone billing and will eventually permit integration with long distance dialing systems.

All of the information to be recorded is first translated into numerals, which are in turn represented by tiny embossed holes punched in varying patterns on a ⅜ in.-wide paper tape. Immediately after dialing, both the calling and the called numbers are recorded. These entries are controlled by the "electrical brain" of the switching system, which has momentarily "memorized" these numbers to set up the connection. After the called subscriber has answered, the starting time of the conversation is recorded. As soon as the parties have finished talking, the time of disconnect is noted.

The tapes are cut daily and taken to the accounting office where clerks feed them into the first of five successive machines. The first machine, which will "read" 250 ft of tape in two hours at the rate of 80 coded digits per second, locates and groups together the various items of information on any single call. This operation, involving the removal of as many as ten sections from the original tape, is required because the entry denoting the end of a conversation may appear on the tape at a point several yards distant from the starting entry. Between the two there may be punches for hundreds of other calls.

Other machines in the series rapidly go through the basic mathematical processes of addition, subtraction, multiplication and division. Relatively complex calculations are also made in converting the elapsed time of a call into chargeable units. A single machine can be set to deal with as many as eight formulas and will select the proper one to solve the problem.

The equipment also performs a variety of other office tasks. For example, it sorts thousands of calls according to the directory number of the subscriber who made them and finally prints the details of the calls on toll slips for use in billing.

The result of fifteen years of development work, the new service is believed to be one of the most significant advances in telephone engineering since the introduction of the dial system.

Symposium Analyzes Effects Of New Thread Standard

A MINIMUM of 10 million dollars will be required by the makers of fasteners to equip their plants for production of the new unified screw threads, provided the industry is permitted to edge into the program gradually over a period of approximately five years. Under the most favorable conditions, two years is seen as a minimum when fasteners with the new screw thread could be coming from the industry in large quantities.

Such was the concensus of 200 fasteners manufacturers who attended a one-day symposium on the new American Standard Screw Threads, sponsored in Cleveland on December 16, by the American Institute of Bolt, Nut and Rivet Manufacturers.

Gage and die makers see a lush business ahead during the transitional period of the fastener industry. A quick and not complete list of new equipment needed in any plant turning out products with the unified screw threads includes new wire drawing dies and new gages to check wire at the heading machines, new heading and extrusion dies with gages to match, go and no-go thread gages for all fine-thread sizes up to 1½ in. dia and for all coarse-thread sizes up to 4 in. in diameter.

Along with the headaches in store for the industry, there is the encouraging feeling that screw, bolt and nut makers will not have to go out and do a job of selling the unified screw threaded products—the demand will originate with the customer and back of the immediate customer will be the federal government.

Since the old and new standards will be interchangeable in ordinary use, there will be a minimum of questioning from the average customer during the transitional period. Old inventories will not be obsoleted.

There has been some indication

from the automotive and kindred industries of their desire to continue the old Class 2 and Class 3 threads. As the makers change over to the new unified thread, the new product will eventually gage loosely when inspected to older standards. This will make it impossible to run both the old and the new standards in one shop without a certain amount of confusion.

According to tentative plans, the larger makers of fasteners expect to change over first on the more common items including carriage and machine bolts, stove bolts and machine screws.

There will be no problem in the change-over insofar as nuts are concerned since the new standards do not change any basic dimensions or hole sizes, but do slightly alter the tolerances.

All who attended the symposium agreed upon one point, handling is to be the greatest problem, starting at the steel mill level and extending through the stock room.

Civilian Walkie-Talkies Get FCC Approval

THE FIRST PORTABLE RADIO transceivers for public use between homes, automobiles, offices, plants, farms and many other person-to-person radio telephone applications are now in pilot plant production. The makers, Citizens Radio Corp. have received the first FCC type approval for equipment to be used on the 465 megacycle band allocated for civilian use.

Equipment is one fourth the size of the famous wartime walkie-talkie, and is the result of more than two years of research and engineering in which many new techniques, including subminiature tubes and the use of silver-on-ceramic circuits, have been perfected.

The transceiver, two of which are required for person-to-person air contact, is housed in a tiny case measuring 6 by $2\frac{7}{8}$ by $1\frac{3}{4}$ in. topped by a small folding antenna. Case contains all necessary equipment except headphone and batteries that are carried in a separate case about the size of a miniature camera. Transceiver with antenna weighs only 11 oz and total station equipment, including batteries is only $2\frac{1}{2}$ pounds.

Head Extension Permits Welding Inside Girder

A UNIONMELT WELDING HEAD that is equipped with a long extension nozzle permits operation through openings one foot square in a deep box girder. Developed by Linde Air Products Co., equipment is used for welding $\frac{3}{8}$ by 12 in. diaphragm plates to the $\frac{1}{2}$ in. thick side plates of support girders for a 60-ton gantry-type dock crane.

The Type U welding head is mounted on a carriage supported by a short track at the rear to provide a 7-foot travel in the direction of the weld. The track can be moved along the length of the girder for welding within successive openings. A small hopper is carried on the end of the nozzle extension to distribute granular material. After cooling, the fused material cracks off and exposes the weld.

Sub-Zero Behavior Of Materials Studied

NEW DATA on the behavior of metals in extreme sub-zero temperatures, which may explain structural failure of many Liberty ships in World War II and the cause of disasters like the East Ohio Gas Co. explosion, are being compiled by a group of researchers at Case Institute of Technology. Research is being conducted at the request of the Office of Naval Research by Dr. W. M. Baldwin, Jr., laboratory head and several assistants.

The findings are being recorded in the metals research laboratory of the Department of Metallurgy, where workers are testing the mechanical properties of steels and aluminum alloys at temperatures as low as 321 deg below zero Fahrenheit.

The low temperatures used in the tests are obtained by forcing liquid nitrogen into a testing chamber of $1\frac{1}{2}$ pints capacity. For intermediate low temperatures a coolant, isopentane and a copper coil are introduced into the chamber.

Tests have already indicated that aluminum alloys are generally better than some structural steels at extremely low temperatures. While under similar conditions, rubber and other materials used for gaskets become so brittle that they break under the slightest pressure.

Guggenheim Funds to Back Jet Propulsion Centers

ESTABLISHMENT of two national centers of rocket and jet propulsion study and research, to be located at Princeton University in the east and California Institute of Technology in the west, has been announced jointly by Harry F. Guggenheim, president of the Daniel and Florence Guggenheim Foundation, Dr. Harold W. Dodds,

president of Princeton University, and Dr. Lee A. DuBridge, president of California Institute of Technology.

Hailed as a major stimulant to the development of rockets and jet propulsion and one of the most striking postwar developments in engineering education, the new institutions will be known as Daniel and Florence Guggenheim Jet Propulsion Centers. Each will provide facilities for post-graduate education and research and will emphasize particularly the development of peacetime uses of rockets and jet propulsion.

The Foundation has underwritten the two Jet Propulsion Centers for a period of seven years, and has appropriated $500,000 for that purpose. These funds are to be used to pay salaries of professors, stipends of graduate students and similar expenses. Necessary buildings and equipment are to be provided by the universities.

Foreign Reports from McGraw-Hill World News

Brazil Plans Aeronautical Centre at Sao Paulo

The British Ministry of Civil Aviation has received a report that Brazil is organizing an Aeronautical Centre to ensure the development of her civil and military aviation. When completed, the Centre will form the counterpart of such American organizations as the CAA's experimental stations at Indianapolis and Arcata, the USAF's Wright Feld and NACA's labs.

The Aeronautical Centre will be located on a plateau at San Jose dos Campos, about 40 miles from Sao Paulo and will include an airport with 12,000 ft runways, modern housing and recreation facilities for 2,000 students and staff, classrooms and research facilities, including wind tunnels.

Plans envisage the building of a specially laid out city and the recruitment of United States experts for the staff. The Centre will have four divisions, of which the first, an Aeronautical Institute of Technology, is already functioning, although not quite complete. This Institute will consist of five schools: Aeronautical engineering, airways engineering, meteorology, electronics, and aircraft production and maintenance. The other three divisions will be organized as funds become available.

Over one million dollars' worth of aeronautical material has already been imported for use in the Centre. For the functioning of the Institute during 1947, the Brazilian Congress voted a sum of approximately $2,848,000.

Eventually, Brazil hopes that the Centre will provide the aeronautical engineers, research technicians and aviation economists required for the development of her aviation. Similarly, she hopes to replace the American staff, which includes Dr. Richard Smith of Massachusetts Institute of Technology as head of the Aeronautical Institute of Technology, and Charles I. Stanton, formerly Deputy Administrator of the Civil Aeronautics Administration, as Dean of the school of Airways Engineering.

First Australian-Built Car Now in Production

Production of the Holden five-passenger sedan by General Motors-Holden Ltd. marks the beginning of Australia's own automobile industry. Designed to fill the driving needs of the 70,000 Australians who want cars, the Holden is of integral body-frame construction and is powered by a 6-cylinder 132.5 cu in. overhead valve engine rated at 21.6 hp. Curb weight is approximately 2,200 lb, wheel base 103 in., overall length 172 in. and overall height just over 5 ft. Fuel economy is 30 miles per U. S. gallon.

Parts and subassembly work is completed at new plants in Victoria and South Australia, while final assembly is done at five existing plants located at Melbourne, Sydney, Birkenhead, Perth and Brisbane.

HOLDEN RESEMBLES prewar American cars but has many features of postwar English models. Developed by GM, car costs $2,200, is slightly smaller than a Chevrolet.

Heat Resistant Paints Developed in Australia

Butyl titanate, produced from rutile and ilmenite, the major components of Australia's "black sand" beach deposits, is the basis for paints that resist temperatures of 1,000 F. Tested on the inside of the main flue stack of a boiler plant, the paint effectively checked corrosion that normally removed 1 oz of steel per square foot for every six weeks. After 32 weeks under these extreme conditions, the paint coating was little affected while test samples of ordinary paints had entirely disappeared.

In addition to its heat-resistant properties, the new paint provides superior protection against salt water corrosion. Preliminary tests indicate that ships will require repainting far less frequently, and as the new paint is not inflammable, fire risks will be greatly decreased.

Butyl titanate can be added to ordinary linseed oil paints to provide resistance to chalking and weathering. It can also be used to impart a matt surface finish to nitrocellulose lacquers.

Its insulating properties are said to be equal to the best transformer oils. Allied titanium derivatives make possible the development of a wide range of plastics with heat-resistant properties, according to a spokesman of the Council for Scientific and Industrial Research.

Washington Notes

AEC Orders Experimental Atomic Engine for Warships

The Atomic Energy Commission has announced that a contract has been arranged with the Westinghouse Electric Corp. to build an experimental atomic engine to propel warships. The project would be carried out jointly by the commission's Argonne National Laboratory in Chicago and the Westinghouse engineers at Pittsburgh.

The development of "specialized nuclear reactors" was among the functions assigned to the Argonne National Laboratory in January 1948. The laboratory will have responsibility for the design, development and engineering of the new reactor, while Westinghouse will undertake its detailed engineering, construction and operation.

An atomic engine for warships could revolutionize naval warfare. The amount of Uranium 235 or other fissionable material required as "fuel" for an atomic furnace is minute in weight compared to the tons of diesel oil or coal burned in a conventional ship engine. It probably would be possible for any normal size warship or submarine to carry enough fissionable material to keep it at sea for years.

Navy Research Chief Urges Nation-Wide Research

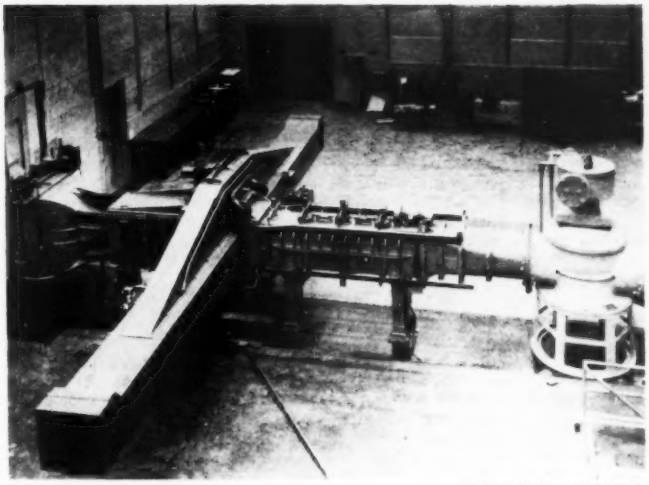
In a speech delivered before the American Council on Commercial Laboratories in Washington, Rear Admiral T. A. Solberg, U.S.N., chief of Naval Research, advocated that research and development in all fields be expanded on a national cooperative basis.

"The Navy policy always has been to have its research and development come back to the man on the street whenever possible. This is one of the reasons why the Navy is particularly interested in fostering integration and cooperation on a nation-wide basis in the fields of science and technical development.

"Foreign sources of new scientific knowledge are meager or non-existent. We do, however, have access to much work which some of our former allies generously make available to us. Both they and we must break through the barriers and frontiers of science, which today are more challenging than ever before. The easy discoveries already have been made, and as we progress in science each step becomes more difficult and more costly. Research in nuclear physics, supersonic dynamics and high temperature metallurgy are typical examples of this.

"It appears today that in research, and perhaps also in development, we have made at least a start on the road to becoming more self-reliant and more independent. During and since the last years of the war, industry has both expanded and added greatly to its research facilities. Industry too, has wisely chosen the method of establishing nominally independent research departments under special management. The services also have recognized that they must be responsible for certain areas of reasearch. But that is not enough.

"From our experience it is evident that support of basic research in universities and other technical institutions could be increased twofold. There are many advantages in using such facilities for basic research. I firmly believe that if selected basic work were so placed under well controlled conditions, that not only industry and the colleges would profit but also our national resources in science would be strengthened."



Official U. S. Navy Photograph

Navy Attains Mach 5.18 in German Wind Tunnels

AN AIR SPEED of Mach number 5.18, equivalent to 3,960 mph under standard conditions, was achieved recently in captured and modernized German supersonic wind tunnels at the Naval Ordnance Laboratory, White Oak, Maryland. This Mach figure, which constitutes a new world's record for tunnels of this size, was reached at —377 F in a 16 in. square working section of the tunnel.

Captured at Kochel, Bavaria by American forces at the conclusion of World War II, the tunnels were dismantled and shipped to the United States in October 1945.

Power is supplied by a huge 52 ft dia steel sphere which is emptied to a near-vacuum by a 300 hp electric motor driving two vacuum pumps.

When the test section is ready, a quick-operating stop cock valve is opened and the pressure difference between atmospheric at the tunnel entrance and the near-zero downstream of the test section produces the high velocities across the throat. These velocities are obtained only between the time the stop cock is opened and the time the sphere pressure approaches atmospheric conditions. At maximum Mach number, this time is 20-40 sec depending on density, pressure and temperature.

Test Gun Fires Guided Missile Warheads

A 24-inch test gun, largest of its type, has been placed in operation at the Naval Proving Ground, Dahlgren, Virginia, to test bombs and guided missile warheads and their fuses.

New gun can project bombs and warheads weighing as much as one ton against armor plate and concrete

targets at supersonic velocities. The effect of the impacts on the missiles and their components will be measured and analyzed, permitting the armed forces to expand their research and development work in the field of ordnance testing.

Test piece is basically the sawed-off and otherwise altered barrel of a standard 16 in. gun. Originally the gun was mounted in the No. 1 turret of the battleship South Dakota, which received a direct hit from a Japanese 500 lb bomb during the battle of Santa Cruz, October 26, 1942.

Policy on Deferments For Scientists Undecided

Deferment of scientists both in industry and in schools is still undetermined. In early battles, Selective Service chief General Hershey has won out over the National Security Resources Board. Because he has not been satisfied with current proposals, he now has a group of five committees, each made up of eminent scientists who are surveying the whole problem. They are to make recommendations which General Hershey can accept or reject as he sees fit.

from induction now. They have been given a stay of induction, if they are otherwise eligible for the draft, until the end of the academic year next

Scientific students are not deferred June. By that time, presumably, a policy may be laid down for dealing with scientists and potential scientists. It may well be the policy followed during World War II. The local draft board may again have the final say, despite the desire of scientists and military to (1) get recognition for the principle that scientists should be placed where they will contribute the most to the successful prosecution of the war, and (2) to set up an operating program now so that World War II misuse of scientists will not begin all over again.

Atomic Clock Provides Constant Time Standard

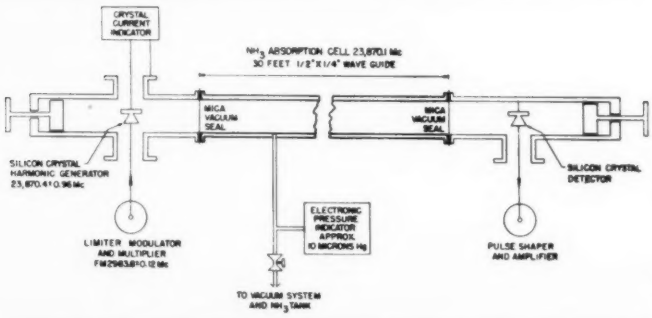
AN ATOMIC CLOCK based on a constant natural frequency associated with the vibration of the atoms in the ammonia molecule has been developed at the National Bureau of Standards. The instrument promises to surpass by one or two orders of magnitude the accuracy of the present primary standard of frequency and time, the rotating earth. Theoretical considerations indicate a potential accuracy of one part in a billion or even ten billion, depending on the type of atomic system and spectrum line used.

The clock can be expected to benefit the communications industries and the military services, for it will, in effect, provide additional room in the radio frequency range for more communication stations of all types. The maximum utilization of available space in the radio spectrum depends on the accuracy with which the frequency of an individual station can be controlled, especially at the higher frequencies where quartz crystals cannot be used as frequency controlling elements. These frequencies, used by radar, television relays and microwave equipment, could be controlled by atomic elements. Such control would also make possible the permanent establishment of radio channels on such an exact basis that tuning could be made as automatic as the dialing of a telephone number.

The improvements in frequency and time measurement offered by the clock are also of fundamental importance in many fields of science. An absolute time standard will be of special importance in astronomy and in every technical field where precise measurements of time and frequency are crucial—for example, in long range radio navigation systems, in the upper range of the microwave region where atomic systems can serve as electronic components and in basic research of microwave spectroscopy and molecular structure.

The NBS clock consists of a crystal oscillator, a frequency multiplier, a frequency discriminator and a frequency divider, all housed in two vertical-type cabinet racks. Above are mounted a special 50-cycle clock and a waveguide absorption cell. Ammonia gas under a pressure of 10 to 15 microns is maintained in the cell, which takes the form of a rectangular $\frac{1}{2}$ by $\frac{1}{4}$ in. copper tube wound around the clock in a compact spiral.

The new equipment utilizes an absorption frequency of ammonia to hold a microwave signal fixed. The microwave signal is initiated by a 100-kilocycle quartz-crystal oscillator of high stability. By means of vacuum-tube circuits and silicon-crystal diodes, this frequency is multiplied to provide output signals throughout the microwave range. Signals are compared with the frequency of a microwave spectrum line—in this case, ammonia gas—by suitable control circuits, often called frequency discriminator or "servo" circuits. If the quartz-crystal oscillator drifts after the microwave signal at the upper end of the multiplier chain has been exactly tuned to the frequency of the spectrum line, the discriminator circuit generates an output or "error" signal which, through proper control circuits, can be applied to the oscillator at the bottom of the multiplier chain to bring it back to the proper frequency. By means of a frequency divider, the 100 kilocycles can be reduced to any desired frequency for driving a clock.


CRYSTAL CURRENT INDICATOR
NH3 ABSORPTION CELL 23,870.1 Mc
30 FEET 1/2" X 1/4" WAVE GUIDE
MICA VACUUM SEAL
MICA VACUUM SEAL
SILICON CRYSTAL HARMONIC GENERATOR 23,870.4 ± 0.96 Mc
SILICON CRYSTAL DETECTOR
ELECTRONIC PRESSURE INDICATOR APPROX. 10 MICRONS Hg
LIMITER MODULATOR AND MULTIPLIER FM 2983.8 ± 0.12 Mc
PULSE SHAPER AND AMPLIFIER
TO VACUUM SYSTEM AND NH3 TANK

WAVEGUIDE ABSORPTION CELL used in NBS Atomic Clock is a spiral-wound copper tube provided with mica windows to seal ammonia gas at pressure of 10-15 microns.

Permanent Exhibit of New Inventions Being Established

A NEW SERVICE, designed to bring together inventors and manufacturers, has just been announced by American Inventors Exhibit, 184 W. Washington St., Chicago, Ill.

The organization is opening a permanent exhibition hall in Chicago's

Loop to which businessmen and manufacturers can come to find new ideas and inventions for use in their business enterprises. Inventions and patents, in virtually every field of endeavor, will be exhibited by their owners. Among the many fields expected to be represented are aviation, radio, television, telephony and railroading.

Stockholm IEC Meeting Highlights Standardization

The International Electrotechnical Commission, the permanent organization working on the standardization of electrical equipment, rounded out its program for 1948 with a congress in Stockholm following meetings in Paris and London in July.

Attending the meeting were sizeable delegations from France, Belgium, Netherlands, Britain, Norway, Switzerland, Italy and Denmark. Countries east of the Iron Curtain were not represented.

Particularly marked progress was registered by the Electric Traction Equipment Committee, where agreement was reached on points that had defied solution for over fourteen years. Whether this was due to the impetus of the Marshall plan was not recorded. Solutions arrived at included alignment of specifications for Class B insulation temperature rises in railroad motors with British and American standards.

Lamp caps standardized by a special committee were two prefocus types, a three-pin bayonet cap, two ceramic caps for sodium lamps and several tubular lamp caps.

To make a separation between "hot" and "cold" connector plugs, the Congress decided to draft a proposal for standardizing the Swedish SEMKO "cold" connector with flat pins as an alternative to the CEE 10 ampere, 250 v connector with round pins.

In an attempt to limit the number of small fuse constructions, the L-system used in Denmark was dropped. The use of pin-type fuses in Belgium, France, Portugal, Switzerland, S. American and other countries showed national divergencies. Steps were taken to iron out these differences.

Swedish stability and discharge tests for capacitors were carefully discussed. Neither appear in other specifications than the Swedish, and the stability test is considered a remarkable attempt to find a test of fairly short duration for giving more conclusive indication than is afforded by the usual tests on the behavior of insulation under operating conditions.

PRESIDENT OF SAE for 1949 is Stanwood W. Sparrow, vice-president in charge of engineering, Studebaker Corp. Well known as one of the leading research executives in the automotive industry, the Society's new leader helped develop the Liberty and Hispano-Suiza aircraft engines at the National Bureau of Standards during World War I. Throughout the last war, he headed Studebaker's production of the Wright Cyclone engine for the B-17 Fortress.

Stress Society Meeting Spotlights Applications

THOSE ATTENDING the annual meeting of the Society for Experimental Stress Analysis held in New York City, December 2-4 were impressed by the growing importance of stress analysis in all phases of design.

Highlights of the 24 papers presented include descriptions of two types of wire resistance strain gages developed to extend the range of static measurements into the plastic region. Components of both are simple materials that are easily applied. Maximum strains up to 18 percent can be measured yet with a maximum error of only 5 percent.

A post-yield theory for measuring inelastic strains up to 2 percent was also outlined. Though approximate, this method is being developed and more accurate techniques are already under study.

Procedures involving the use of a chart for the rapid selection and determination of proper strain gage output were demonstrated. Considerable interest was also exhibited in techniques for measuring rapidly-varying temperatures in the order of 1,000 deg F per sec, and for repetitive measurement of slowly-varying temperatures.

MEETINGS

January 31-February 4
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Winter General Meeting, Hotel Pennsylvania, New York, N. Y.

February 21-22
MATERIALS HANDLING INSTITUTE—Materials Handling Conference, Purdue University, Lafayette, Ind.

February 28-March 4
AMERICAN SOCIETY FOR TESTING MATERIALS—Spring Meeting, Hotel Edgewater Beach, Chicago, Ill.

March 8-10
SOCIETY OF AUTOMOTIVE ENGINEERS—Passenger Car, Body and Production Meeting, Book-Cadillac Hotel, Detroit, Mich.

March 10-12
AMERICAN SOCIETY OF TOOL ENGINEERS—Seventeenth Annual Meeting, Hotel William Penn, Pittsburgh, Pa.

March 14-17
CHICAGO TECHNICAL SOCIETIES COUNCIL—1949 Chicago Technical Conference and Show, Hotel Stevens, Chicago, Ill.

March 28-30
SOCIETY OF AUTOMOTIVE ENGINEERS—Transportation Meeting, Statler Hotel, Cleveland, Ohio.

April 11-12
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Conference on Industrial Application of Electron Tubes, Statler Hotel, Buffalo, N. Y.

April 11-13
SOCIETY OF AUTOMOTIVE ENGINEERS—Aeronautic and Air Transport, and Aircraft Engineering Display, Hotel New Yorker, New York, N. Y.

April 11-14
NATIONAL ASSOCIATION OF CORROSION ENGINEERS—Fifth Annual Conference and Exposition. Netherland-Plaza Hotel, Cincinnati, Ohio.

April 11-15
AMERICAN SOCIETY FOR METALS—Western Metal Congress and Exposition, Shrine Civic Auditorium, Los Angeles, Calif.

April 25-29
AMERICAN SOCIETY OF MECHANICAL ENGINEERS—Oil and Gas Power Division Conference, Hotel Sherman, Chicago, Ill.

another big "scoop" for R/M brake linings

In the history of industrial friction materials, R/M has been first with so many developments* that it's no surprise to find R/M designing and supplying the brake lining for the world's largest drag line bucket . . . a giant of 50 cubic yards capacity!

How to keep the door of this huge bucket from crashing loose when unloading posed an unusual brake problem. R/M solved it by developing a new combination of friction material, with a snubbing action that cushions the load. Now, R/M supplies this same material as standard equipment. Experience of this sort is invaluable to manufacturers with problems in design of brakes or clutches, or in supply of friction materials.

Whatever your products . . . from drag lines to adding machines, from trucks to motorcycles . . . you'll find the R/M representative well-informed and helpful. Call him in. Behind him stand four great plants, four research organizations, and four testing laboratories . . . *all* the facilities of the largest producer in the friction material industry.

*AMONG R/M "FIRSTS" IN BRAKE LINING: Woven Brake Lining • Asbestos Brake Lining Ground Wearing Surface • Zinc Alloy Wire Brake Lining • Pre-Treated Yarns Extruded Pulp Brake Lining • Flexible Pulp Brake Lining in Rolls • Dry Process Brake Lining Semi-Metallic Brake Lining • Bonded-to-Metal Brake Lining

RAYBESTOS-MANHATTAN, INC.

EQUIPMENT SALES DIVISION **620 Fisher Bldg., Detroit 2, Mich.**

445 Lake Shore Drive, Chicago 11, Ill. 4651 Pacific Blvd., Los Angeles 11, Calif.

1017 Union Commerce Bldg., Cleveland 14, Ohio

Factories: Bridgeport, Conn. Manheim, Pa. Passaic, N. J. N. Charleston, S. C.

RAYBESTOS-MANHATTAN, INC., Manufacturers of Brake Linings • Brake Blocks • Clutch Facings Fan Belts • Radiator Hose • Mechanical Rubber Products • Rubber Covered Equipment • Packings Asbestos Textiles • Powdered Metal Products • Abrasive and Diamond Wheels • Bowling Balls

R/M

FIRST IN FRICTION

Radial Stress in Linearly Tapered Turbine Blades

JOSEPH R. BRESSMAN
Research Engineer, DeLaval Steam Turbine Company

THE RAPID DEVELOPMENT of the gas turbine has introduced many new problems in turbine design. At the high temperatures at which the blades operate the design stresses that can be used are limited. As a consequence, blades are often tapered so that the blade area at the tip is substantially smaller than that at the base. In many designs the blades are cooled indirectly by conduction to the disk or directly by air passing through the center of a hollow blade. The radial blade position that is critical from the design stand-point is then a function of both the radial temperature and stress distributions.

The design charts on pages 157 and 159 simplify the determination of the radial stress distribution in a turbine blade caused by direct centrifugal loading. It is only necessary to determine two geometric parameters; α, the ratio of the tip area to the root area; and L/R_t, the ratio of the blade length to the blade tip radius. Choosing the proper chart the stress factor F can be found for any tangential cross-section of the blade. This factor multiplied by the weight density ρ of the material and the square of the tip speed V_t^2 gives the stress at any particular cross-section.

An example will illustrate the use of the charts. Assume a turbine blade having the following characteristics:

$\alpha = 1.5$, $L/R_t = 0.20$
$\rho = 0.300$ lb per cu in., $V_t = 1,000$ fps

and it is desired to determine the stress at the root of the blade, that is, where the ratio of Y/L is zero.

For α equal to 1.5, values of F are given on Chart 2. This chart gives 0.044 as the value of F when Y/L is 0, and L/R_t is 0.20. The stress S at the root of the blade is then found from

$$S = F(\rho V_t^2) = 0.044 \times 0.300 \times 1,000^2$$
$$= 13,200 \text{ psi}$$

Although many gas turbine and axial flow compressor blades are twisted, the usual method of design is to align the principal axes of the cross-sections above each other to minimize the bending moments. The average direct stresses are then maintained within safe limits. For highly twisted blades, however, the bending moments caused by centrifugal loading should be taken into account. The following analysis assumes a blade that is linearly tapered in cross-section area from root to tip and in which there are only direct tensile stresses caused by centrifugal force acting on any tangential cross-section.

Nomenclature

A = area of blade at any arbitrary section, sq in.
A_r = area of blade at the root section, sq in.
A_t = area of blade at the tip section, sq in.
C = centrifugal force, lb
F = stress factor for calculating direct centrifugal stress
g = acceleration of gravity, in. per sec per sec
L = blade length, in.
R_t = radius at tip, in.
R = radius at arbitrary blade section, in. $= R_t - L + Y$
S = direct centrifugal stress, psi
V_t = blade tip speed, in. per sec. (use ft per sec for charts)
Y = distance from root to arbitrary blade section, in.
α = ratio of tip area to root area $= A_t/A_r$
ρ = weight density of material, lb per cu in.
ω = angular velocity of turbine disk and blades, radians per sec

For a linear variation in cross-sectional area from root to tip

$$A = \frac{A_t}{\alpha}\left[1 + \frac{Y}{L}(\alpha - 1)\right]$$

The differential equation for centrifugal force on any section A of thickness dy is

$$dC = \frac{\rho\omega^2}{g} R A \, dY$$

$$= \frac{\rho\omega^2}{g}(R_t - L + Y)\left(\frac{A_t}{\alpha}\right)\left[1 + \frac{Y}{L}(\alpha - 1)\right] dY$$

The total force on cross-section A caused by the centrifugal load of that part of the blade above A is

$$C = \frac{\rho\omega^2 A_t}{\alpha g}\int_Y^{L}(R_t - L + Y)\left(1 + \frac{Y}{L}(\alpha - 1)\right) dY$$

Substituting V_t^2 for $\omega^2 R_t^2$ and integrating, the stress S at any section is

$$S = \frac{C}{A} =$$

$$\rho V_t^2 \left\{\frac{1}{2g\left[1 + (Y/L)(\alpha - 1)\right]}\left[(\alpha - 1)\left(\frac{L}{R_t}\right)^2\left(\frac{R_t}{L} - \frac{1}{3}\right) + 2\left(\frac{L}{R_t}\right)\left(1 - \frac{L}{R_t}\right) + \left(\frac{L}{R_t}\right)^2 - (\alpha - 1)\left(\frac{R_t}{L} - 1 + \frac{2Y}{3L}\right)\left(\frac{Y}{R_t}\right)^2 - 2\left(1 - \frac{L}{R_t}\right)\left(\frac{Y}{R_t}\right) - \left(\frac{Y}{R_t}\right)^2\right]\right\} \quad (1)$$

Inasmuch as

$$\frac{Y}{R_t} = \left(\frac{Y}{L}\right)\left(\frac{L}{R_t}\right)$$

the term in the braces, which is the quantity F plotted in the charts, is a function only of the three dimensionless parameters α, L/R_t and the blade position Y/L.

At the root of the blade, Y is 0, then from Eq (1) the stress at that section is

$$S_r = \frac{\rho V_t^2}{2g}\left[(\alpha - 1)\left(\frac{L}{R_t}\right)^2\left(\frac{R_t}{L} - \frac{1}{3}\right) + \left(\frac{L}{R_t}\right)\left(2 - \frac{L}{R_t}\right)\right]$$

For an untapered blade where α equals 1, the stress at any section is

$$S = \frac{\rho V_t^2}{2g}\left\{1 - \left[1 - \frac{L}{R_t}\left(1 - \frac{Y}{L}\right)\right]^2\right\}$$

By evaluating the function in the braces of Eq (1) for various values of L/R_t, Y/L and α the stress F can be plotted as in Charts 1, 2, 3 and 4. The stress at any tangential cross-section of the blade can then be expressed as

$$S = F(\rho V_t^2)$$

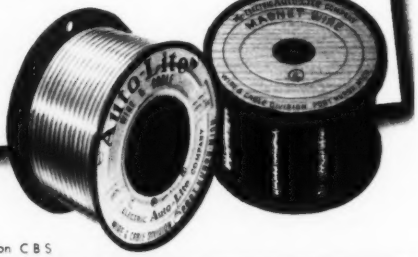
Values of F in Charts 1, 2, 3 and 4 are to be used with ρ expressed in units of pounds per cubic inch and V_t expressed in feet per second.

(*Continued on page 157*)

The right wire for the right job!

Technological advances in many industries constantly require new developments and new applications of wire and cable. A space-saving wire design has made possible smaller, more compact motors. A new and better form of heat resistance in turn prevents failure in generators. Again, if a sharp turn can be given a wire, a new and better clock may be possible. New abrasion characteristics may mean milady's iron won't fail. A city's safety is made more certain because a solenoid sets new records in performance. As simple a thing as better shielding in a wiring harness can be the secret of clearer radio and television reception. Auto-Lite Engineers have had many years' experience in answering such problems. For more complete information on the "right wire for the right job" write to

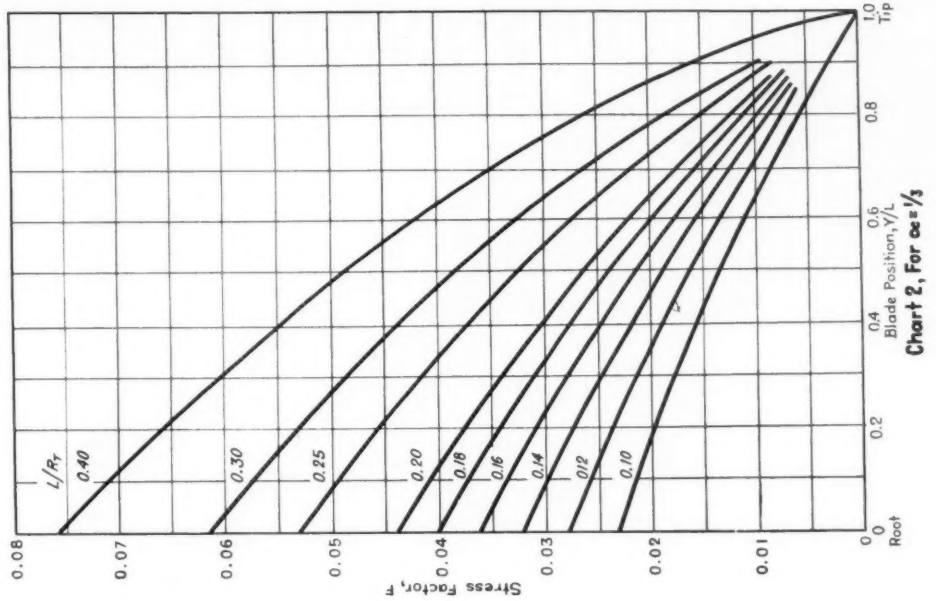
THE ELECTRIC AUTO-LITE COMPANY
Wire and Cable Division
Sarnia, Ontario • Port Huron, Michigan

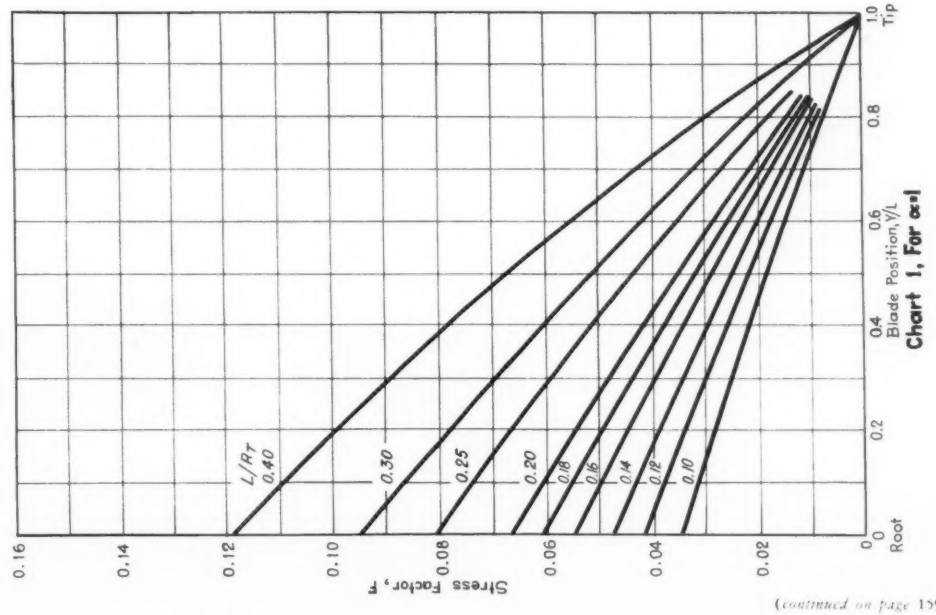


Tune in "Suspense!," radio adventure at its greatest—Thursday, 9 p. m., E. S. T. on C B S

AUTO-LITE ELECTRICAL WIRE and CABLE

Radial Stress in Linearly Tapered Turbine Blades (continued)





(continued on page 159)

Stainless outlasts another metal 6 times at 1500°F!

Combustion chambers and deflector rings in oil-fired crop driers reveal how ARMCO Stainless Steels solve high temperature equipment problems. For example, deflector rings made of another commonly used metal fail after less than a season's service because of scaling and warping in temperatures up to 1500°F.

But when these parts were made of heat-resisting ARMCO Stainless Steel, they lasted more than six times as long as the other metal.

Besides saving time and trouble by eliminating frequent replacements, Stainless Steel combustion chambers and deflectors actually cost 25 to 50% less per year of service.

If this experience with Heat-Resisting ARMCO Stainless Steel suggests its use in your products exposed to high temperatures, ARMCO Engineers will be glad to work with you. Just write Armco Steel Corporation, 45 Curtis Street, Middletown, Ohio.

Are You PAYING for Stainless But Not Using It?

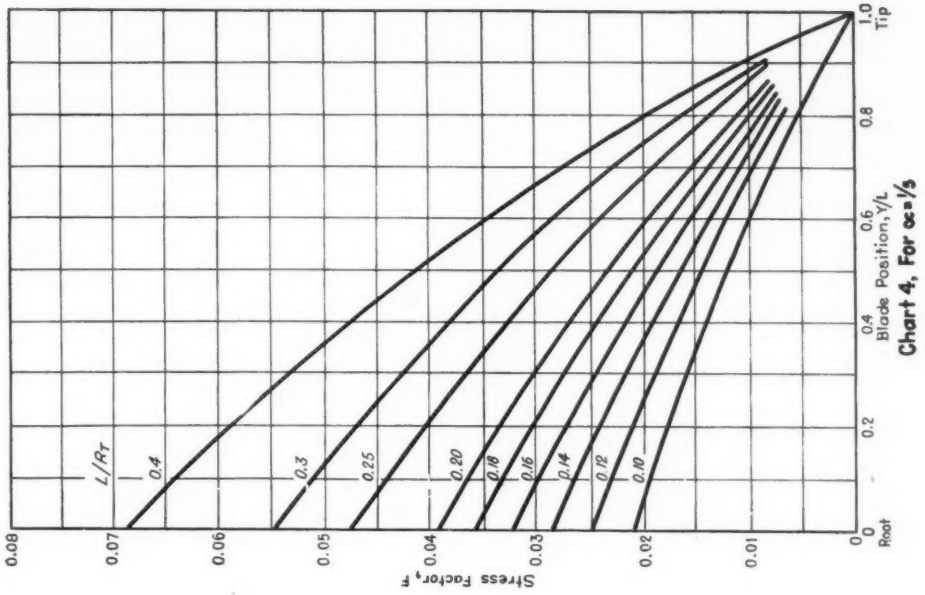
Labor costs are such a large part of the final cost of your products or equipment that ARMCO Stainless Steel is more than ever your "best buy" for today's dollar. This is why:

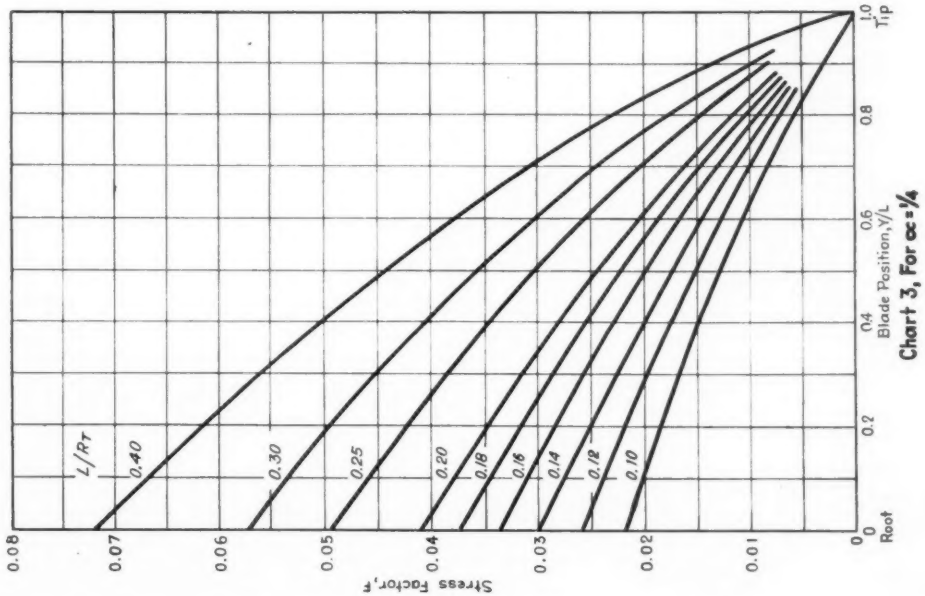
1. In production equipment, long-range costs of ARMCO Stainless are lower than for short-lived materials because of fewer costly replacement installations, much less maintenance expense.
2. Operating costs are lower too because Stainless equipment is easy to keep clean and efficient. There is less "down-time."
3. First cost in consumer products is *actually lower* in many cases, because no plating is needed to protect this solid rustless metal.
4. Sales appeal is tops. Buyers prefer Stainless for its lasting beauty, its trouble-free service.

ARMCO

ARMCO STAINLESS STEELS

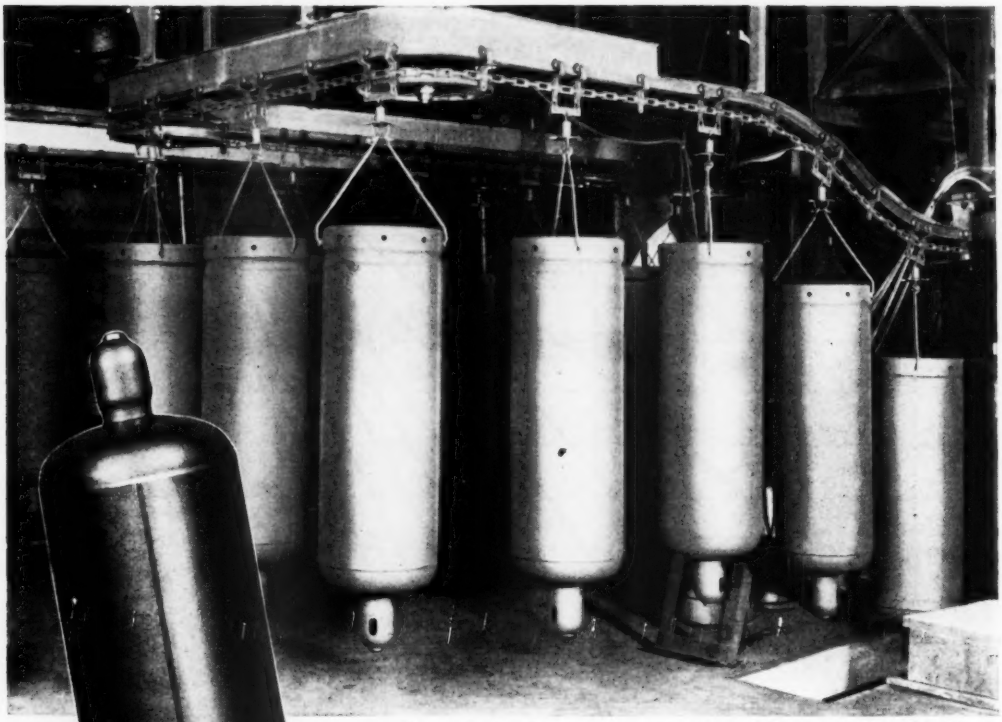
Radial Stress in Linearly Tapered Turbine Blades (continued)





N-A-X HIGH-TENSILE STEEL in L.P.G. Cylinders

means light weight with added safety and durability



Photographs of the Lee cylinder, courtesy of the Steel Cooperage Company, Detroit.

Because of the greater strength and excellent fabricating, welding and copper brazing properties of this low-alloy, abrasion- and corrosion-resisting steel, cylinders made with it (to conform to I.C.C. safety requirements) are 35% lighter in weight than when made with conventional carbon steel.

This weight reduction (with longer life) means greatly reduced shipping and handling costs . . . and over-all savings to consumers.

MAKE A TON OF SHEET STEEL GO FARTHER
Specify—
N-A-X
HIGH-TENSILE STEEL

COPYRIGHT 1948
GREAT LAKES STEEL CORPORATION

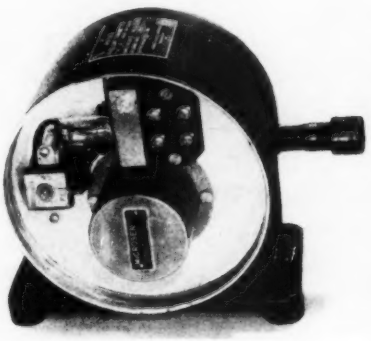
GREAT LAKES STEEL CORPORATION

N-A-X ALLOY DIVISION • DETROIT 18, MICHIGAN
UNIT OF NATIONAL STEEL CORPORATION

NEW MATERIALS AND PARTS

INDEX OF ITEMS

Product	Manufacturer	Page
Alloy Steel, Free-Machining	Joseph T. Ryerson & Son, Inc.	170
Analyzer, Metal	J. W. Dice & Co.	168
Cabinet, Blue Print	Empire Development Corp.	172
Coating, Styrene Resin	American Cyanamid Co.	172
Connector, Coaxial	General Radio Co.	164
Controller, Electronic Load	G. C. Wilson & Co.	162
Corrosion Inhibitors	Rotometals, Inc.	170
Expansion Joints, Rubber	The Garlock Packing Co.	168
Filters, Air Line	M-B Products	172
Filter, Oil & Fuel	W. G. B., Oil Clarifier Inc	172
Fluxmeter Calibrating Unit	General Electric Co.	170
Furnace, Laboratory	Pereny Equipment Co.	172
Gages, Hydraulic	A. Schrader's Son	170
Gas Analyzer	Bailey Meter Co.	172
Hinges, Structural	Moyanhan Bronze Co.	164
Indicator, Smoke	Brooke Engineering Co	170
Lubricant, Fire-Resistant	Monsanto Chemical Co.	170
Metal Press Unloader	Sahlin Engineering Co.	161
Meter, Combination	International Instruments Co.	166
Motors, Bearing Mounted	The Hoover Co.	164
Motors, Industrial	Electric Boat Co.	161
Nut Retainers	Tinnerman Products, Inc.	166
Oscillograph, Cathode Ray	The Hickok Electrical Instrument Co.	168
Paint, Stainless Steel	The Lockrey Co.	168
Pressure Transmitter	Manning, Maxwell and Moore, Inc.	161
Primer, Paint	Princeton Paint Laboratories	162
Pump, Liquid Handling	Eco Engineering Co.	162
Pump, Motorized Jet	Goulds Pumps Inc.	166
Pyrometer, Low Temperature	Brown Instrument Co.	164
Regulator, D-C Power	Hastings Instrument Co.	162
Relays, Small Magnetic	Ward Leonard Electric Co.	168
Rivets, Threaded	Cherry Rivet Co.	161
Speed Reducers	Boston Gear Works	168
Switch, Rotary Stepping	Automatic Electric Co.	162
Valves, Solenoid Air	Vikings Products Co.	166



Pressure Transmitter

Manning, Maxwell and Moore, Inc., 11 Elias St., Bridgeport, Conn.

With this electronic transmitter, pressure motion is picked up from the tip of a Bourdon tube; and by means of a Microsen electro-mechanical relay, this motion is converted into a stable d-c signal which can be indicated or recorded with milliamp or millivolt instruments. Uniformly graduated reading scales can be used because the electrical output is directly proportional to movement of Bourdon tube. To meet specific requirements, alloy steel, bronze, stainless steel or other materials can be used in the Bourdon tubes. Housing case is cast aluminum, and instrument operates on 115 v, 50-60 cycle a-c with pressures up to 50,000 lb at a power output of 2 watts.

Metal Press Unloader

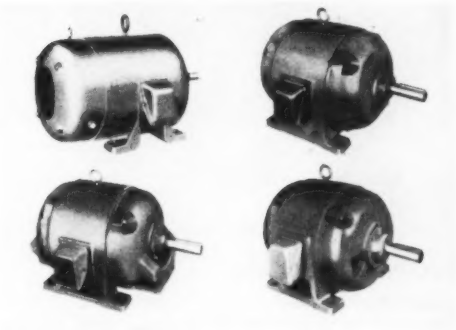
Sahlin Engineering Co., 467 S. Woodward, Birmingham, Mich.

A metal grip arrangement for removing parts from draw presses is a separate piece of equipment. As its operating cycle does not depend on the press, the unloader can be timed to remove the panel at any time during the die's upward stroke. It can be designed to lift the panel vertically and therefore, can eliminate spring or air lift-outs in the lower die. In operation, jaws of this mechanism move into the die, take a firm hold on panel, lift the panel out of the die, and swing it out on to a table or conveyor. Stroke of the jaw is dependent on length of the connecting arm which is telescoped to provide 24 in. adjustment.

Threaded Rivets

Cherry Rivet Co., 231 Winston St., Los Angeles 14, Calif.

Blind rivets for fastening heavy gage metal sheets are available in $\frac{1}{4}$, $\frac{5}{16}$, and $\frac{3}{8}$ in. dia and in grip lengths from $\frac{1}{8}$ to $\frac{3}{4}$ in. The rivet material is steel and the head type is protruding. After the rivet has been inserted an automatic screwdriver, fitting into the head of a steel screw machine, rotates the screw and draws the collar into the rivet. The rivet expands as the screw is driven into its shank. The screwdriver can be adjusted to tighten the rivet to a preset torque.

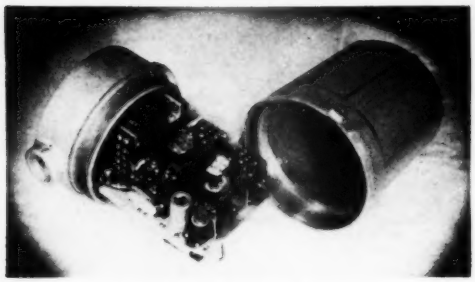


Industrial Motors

Electric Boat Co., Electro Dynamic Div., New London, Conn.

Line of industrial motors are available in a variety of inclosures, including drip-proof, splash-proof, totally inclosed fan cooled and totally inclosed non-ventilated. Motors have vinyl-coated stator coils and insulation

between phases. Complete stators are baked with phenolic base synthetic varnish. Rotors consist of steel laminations wound with rolled copper or brass in ring-and-bar construction. All are polyphase squirrel-cage induction motors, and are available in sizes from 1 to 60 horsepower.



Electronic Load Controller

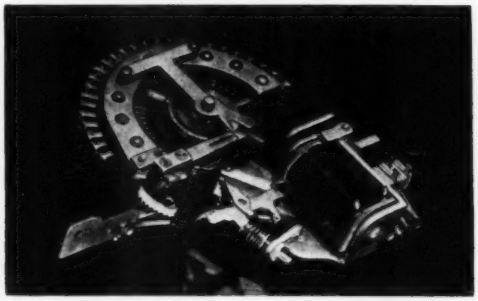
G. C. Wilson & Co., Dept. C, 2 N. Passaic Ave., Chatham, N. J.

Load controller, known as the Flexi-Trol, is suitable for use wherever motors are used in processing equipment. Instrument controls the feed of material to the equipment, and consists of two units: a pick-up coil connected to the motor lead, and an electronic unit made up of two identical radio type vacuum tubes plus four magnetic relays. If an overload occurs in handling equipment, the Flexi-Trol initiates a time delay, thus shutting down the feeding motors. If, at the end of this delay period, the overload still exists, the feeding motors are shut off and must be restored to service manually. Time delays can be adjusted for 1 to 8, or 20 to 30 seconds.

D-C Power Regulator

Hastings Instrument Co. Inc., Hampton, Va.

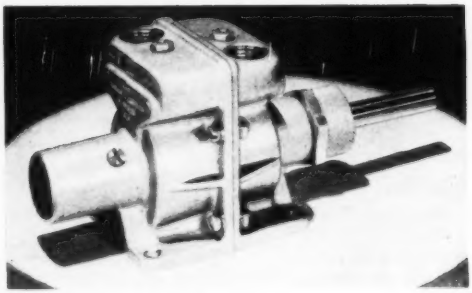
Developed for instruments which require stable d-c voltages, power supplied through this instrument is suited for resistance thermometers, wire strain gages, position potentiometers, recording oscillographs, and other instruments. Regulated power supply is adjusted by manufacturer at any specified load from 5 to 30 milliamp and for any output voltage from 0 to 100 v. Voltage regulation is obtained within 0.1 percent and ripple less than 0.01 percent. Unit measures 4 x 5 x 6 inches.



Rotary Stepping Switch

Automatic Electric Co., 332 S. Michigan Ave., Chicago 4, Ill.

Designated as Type 45, the switch is adaptable to a variety of electrical control requirements, such as remote selection of circuits by means of either external pulsing or self-pulsing control. Mechanism can be provided with up to 15 bank contact levels, and it can be supplied with single ended contact brushes to provide up to 50 outlets. When equipped with 10 contact brushes, switch can be adjusted to operate at speeds up to 70 steps per sec when self-pulsed, or up to 35 steps with external pulsing on 46 v direct current.



Liquid Handling Pump

Eco Engineering Co., 12 New York Ave., Newark 1, N. Y.

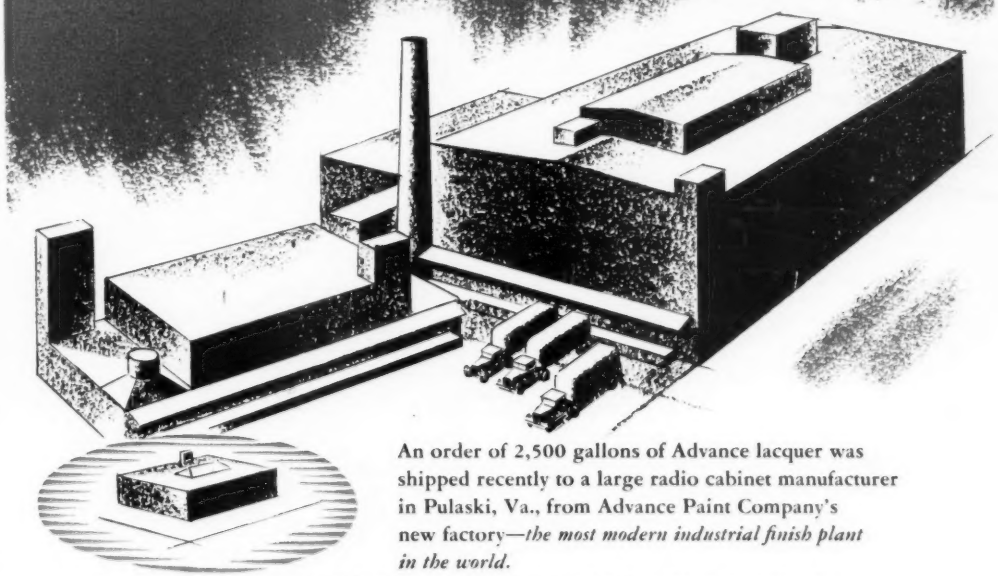
Liquid handling, gearless pumps are available for use on pressures ranging from 0 up to 100 psi. Work with these pressures is said to be made possible by duel eccentric piston design. Pumps are fitted with self-lubricating bearings, and are made in four sizes, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$ inches. They have capacities from 1 to 12 gpm, and will deliver at speeds from 200 to 2,400 rpm. Pump body is either naval bronze or stainless steel depending on the fluids to be handled.

Paint Primer

Princeton Paint Laboratories, Room 3107, Empire State Bldg., New York 1, N. Y.

Primer 10 is an air drying and baking primer for all metals. From accelerated weather tests, it was determined that both air dry and baked primer film retained its

FIRST SHIPMENTS MADE FROM WORLD'S MOST MODERN INDUSTRIAL FINISH FACTORY



An order of 2,500 gallons of Advance lacquer was shipped recently to a large radio cabinet manufacturer in Pulaski, Va., from Advance Paint Company's new factory—*the most modern industrial finish plant in the world.*

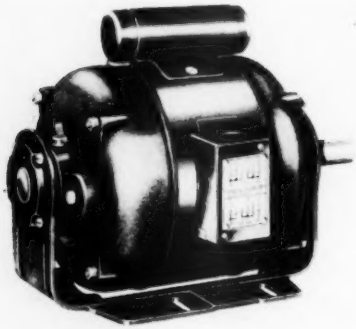
This shipment marked the beginning of better finishes and better service for Advance customers. The new factory utilizes the latest methods of product control, complete gravity-flow processes and equipment designed especially for this plant . . . increases manufacturing facilities six times.

Advance designed its new factory on the basis of 50 years experience in formulating finishes to the requirements of specific jobs. Plan your production schedules around Advance's ability to meet your finish requirements faster.

Manufacturers of Industrial Finishes

Advance PAINT COMPANY
INDIANAPOLIS, INDIANA

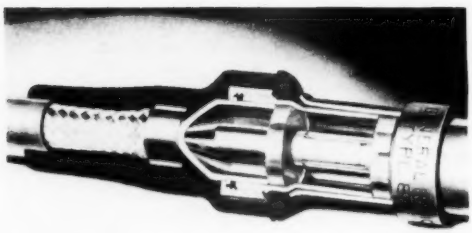
flexibility and adhesion under severe conditions. All test panels were scratched through to the metal before weathering in order to note corrosion creepage under the film, but in no case was this common breakdown evident. Five minutes air drying gives a dust-free surface suitable for overcoating with synthetics in 30 min, but lacquer type overcoating requires baking of primer.



Bearing Mounted Motors

The Hoover Co., Kingston-Conley Div., North Plainfield, N. J.

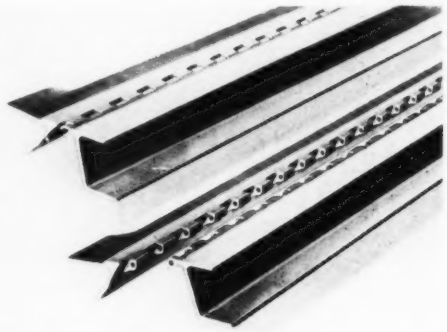
Rigid base, bearing mounted motors are built to NEMA mounting standards. They are made with either sleeve or ball bearing mounts. The former include wool packed bearings with oil reservoirs and oil return grooves. Ball bearing motors can be installed in any position from horizontal to vertical, and motors with either of these two types of mount are available in ratings of $\frac{1}{4}$, $\frac{1}{3}$ and $\frac{1}{2}$ hp. They are single phase, 1725 rpm, dual voltage motors.



Coaxial Connector

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Type 874 coaxial connector is a universal unit for use on coaxial lines with 50 ohm impedance at frequencies from 0 to over 4,500 megacycles. The basic elements of the connector are an inner and outer conductor and a supporting polystyrene bead. The former two parts of the connector are two tubes with four longitudinal slots in the end of each. To make a joint, two connectors are plugged together so that the undisplaced quadrants of one connector overlap the displaced quadrants of the other. A friction grip is made by multiple, spring-loaded contacts; no other locking means is required. These connectors can be used on panels, cables and rigid lines.



Structural Hinges

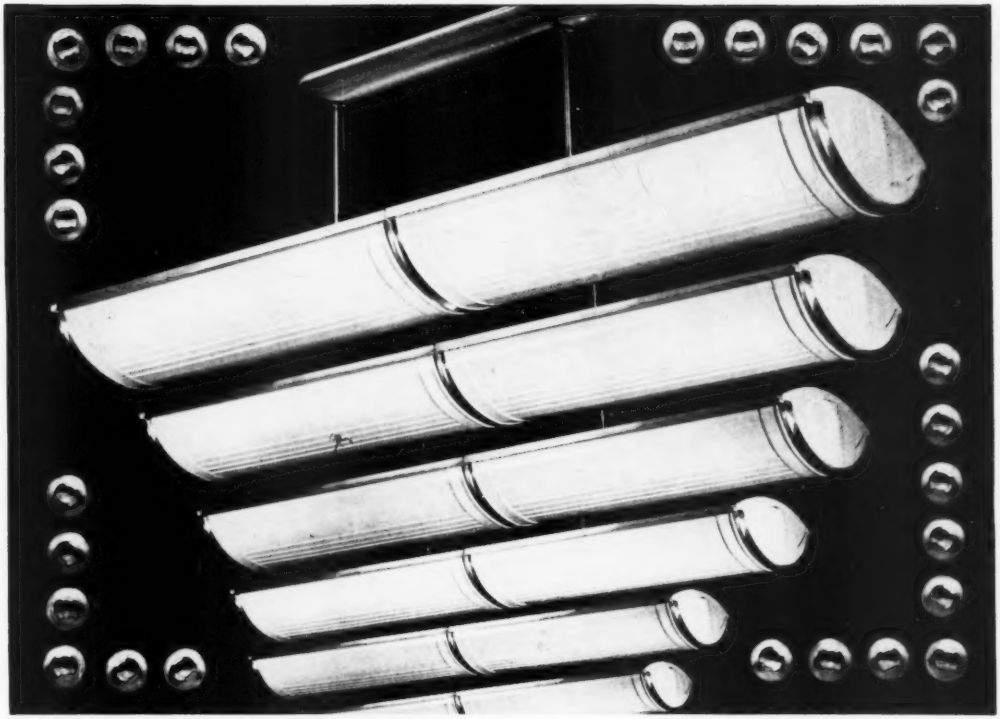
Moynahan Bronze Co., 9082 Alpine, Detroit, Mich.

These hinges, which are available in lengths up to 12 ft, are made of aluminum alloys, 24ST and 75ST, and are produced by extrusion. Drilling of the pin holes is accurate enough to allow for good fits. In addition to their obvious service, these hinges also fulfill the function of structural members.

Low Temperature Pyrometer

Brown Instrument Co., 4494 Wayne Ave., Philadelphia 44, Pa.

Designed to indicate and control temperatures in the 100 to 600 F range, instrument operates in conjunction with an electronic potentiometer. Radiation of heat from the object whose temperature is to be measured is focused by a lens on a series of small thermocouples which create a minute emf. The potentiometer receives this emf and amplifies it to operate a recording pen, or to actuate a controlling mechanism. To lessen the effects of ambient temperature at the thermopile, a sensitive resistance winding and heating element are included in the radiation detecting unit. Overall sensitivity of pyrometer lies between 1 and 2 deg within range of 100 to 212 F and sensitivity increases with temperature. (*Continued on page* 166)



TYPE "A" ASSEMBLY BIT

COMMON SCREWDRIVER

Only CLUTCH HEAD *Could Qualify Here*

At Vermillon, Ohio, where they produce commercial lighting fixtures that compete with daylight, they had their production problems.

The F. W. Wakefield Brass Co. state frankly that they solved these problems by designing three fluorescent models . . . Beacon, Diplomat, and Star . . . for standardization on CLUTCH HEAD Screws. Following experiment and experience with slotted and other types of recessed head screws, the Wakefield people say:—

"We believe our assembly job would have proved impracticable without CLUTCH HEAD's improved type of screw."

"Use of CLUTCH HEAD immediately saved us 35% in assembly time."

"Previously, damage from driver skidding was *VERY* serious . . . Now we have none."

"The absence of 'ride-out' with CLUTCH HEAD's non-tapered drive means safer as well as easier driving for higher production."

"Today we use only one Type 'A' Bit per week as against 16 previously used with other type screws."

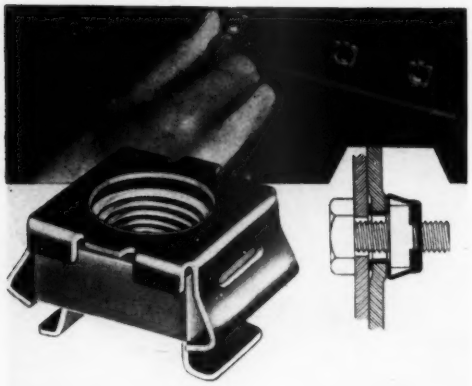
"The Lock-On feature has 2-way importance for us. It simplifies both assembly and field-servicing of our units."

Regardless of the nature of your product, you will find in America's Most Modern Screw advantages covering every phase of assembly production . . . for increased output at lower cost through safer, faster and smoother operation. Make your own appraisal of these advantages. Send for package assortment of Sheet Metal, Thread-forming and Machine screws, sample Type "A" Bit, and illustrated Brochure.

CLUTCH HEAD SCREWS

UNITED SCREW AND BOLT CORPORATION

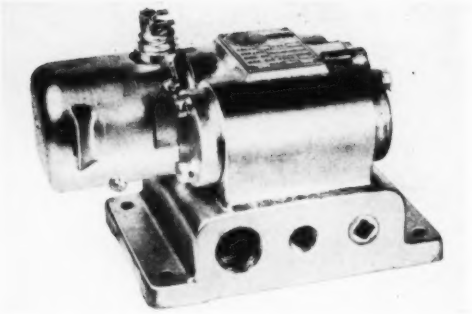
CLEVELAND 2 CHICAGO 8 NEW YORK 7



Nut Retainers

Tinnerman Products Inc., 2039 Fulton Rd., Cleveland 13, Ohio

Speed grip nut retainers are available in 16 different sizes to accommodate nuts that will fit screw sizes from 8-32 to $\frac{3}{8}$-20. Retainers, housing the nut securely, permit a bolt to be threaded, although only one side of the installation is accessible. Spring steel prongs hold the nut and retainer to the sheet metal until the bolt is secured. When the latter is tightened, the nut aligns itself. Even after tightening, the nut and nut retainer can be removed by hand for convenience in servicing the installation.



Solenoid Air Valves

Viking Products Co., 2373 E. Eight Mile Rd., Hazel Park, Mich.

In all Ring-Seal air valves the valve assemblies are of the double opposed poppet type which are reversible and removable from either end of valve housing. The design of this valve assembly is such that valve speeds up to 600 strokes per min can be accomplished; and since valves are direct acting and positive in operation no pilot valves are required. Three or four-way assemblies are provided with either 3, 4 or 5 ports, the openings of which are in the bottom as well as in the sides of the valve body. Built to operate with 110 v 60 cycle a-c, and with air pressures up to 105 psi, solenoids for other frequencies and voltages can be supplied.

Motorized Jet Pumps

Goulds Pumps Inc., Seneca Falls, N. Y.

Pumps built in 9 sizes from $\frac{1}{4}$ to 5 hp are suitable for handling water, gasoline, alcohol, carbon tetrachloride, and similar liquids. They are adapted for such industrial applications as boiler feeding, filter press service, air conditioning and refrigeration. In the operation of the unit a centrifugal pump circulates the liquid, discharging it first into the air separation chamber. Liquid then goes through the nozzle and diffuser and back into the centrifugal pump. Suction lift up to 22 ft is obtained by means of a vacuum created by the action of the jet. Pumps can deliver a maximum of 35 gpm, and working pressures range from 30 to 190 psi. Impeller, guide vane, nozzle and diffuser are bronze.

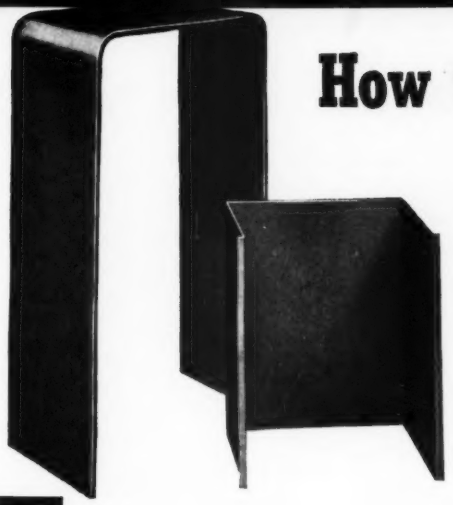
Combination Meter

International Instruments Inc., 311 East St., New Haven 11, Conn.

Instrument is a combination volt and ohm meter which tests resistances from 0 to 2 million ohms with an accuracy of ± 2 percent of linear scale. When testing voltages it registers from 0 to 300 v d-c or a-c. Instrument is fitted with a toggle switch for a-c and d-c testing and a pair of jacks into which test leads are inserted. A rotary switch is also provided for selection of various voltage and resistance ranges. Meter has two dry batteries inclosed in the base for powering the meter action.

(*Continued on page 168*)

How to *Form* metal cabinets on a PRESS BRAKE!



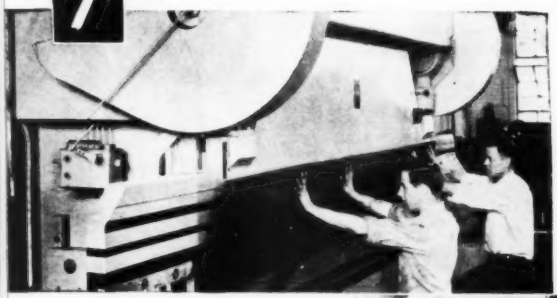
By extending bed and ram beyond the ends of the press and installing tangent bending mechanisms, BATH has added cabinet forming to the already wide range of functions of its STURDYBENDER Press Brake.

Now it is possible to do a complete job on one machine—blanking, perforating, notching, bending of flanges *and forming*. Obviously, this method provides a tremendous savings in the handling of materials, and eliminates the need for special forming equipment. The tangent bending mechanism is adjustable, to permit forming a wide variety of shapes. Cabinets for refrigerators, washing machines, deep freeze units, vending machines and other similar products are already being formed by this means.

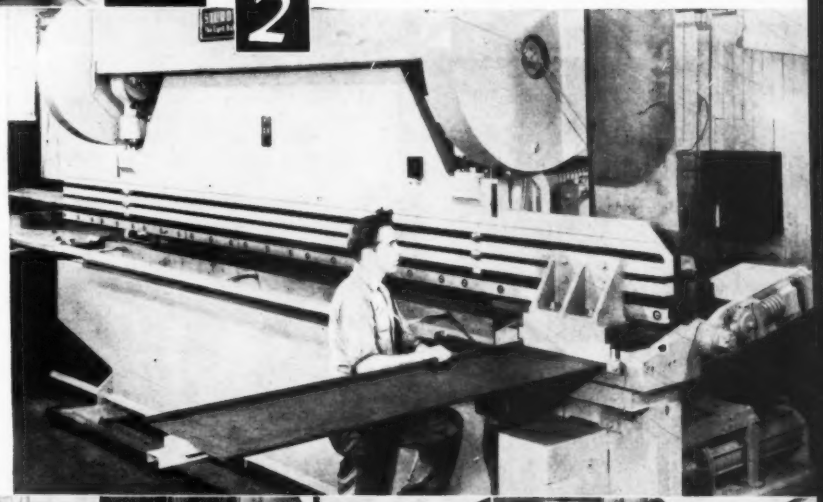
Since more and more manufacturers are finding the STURDYBENDER tangent bending device an economical answer to their cabinet forming problems, you, too, may be interested in the details. A letter will bring full information.

The CYRIL BATH COMPANY
6987 MACHINERY AVENUE
CLEVELAND 3, OHIO

1



2



First step in production of refrigerator shell is forming 90° flange and lock flange on sides of flat sheet, conventional press brake operations.

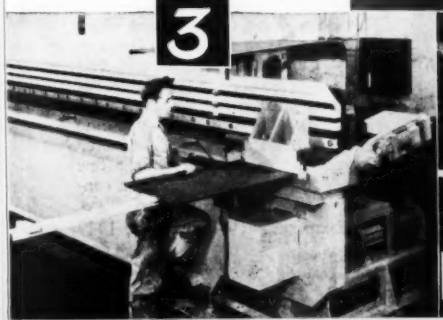
•

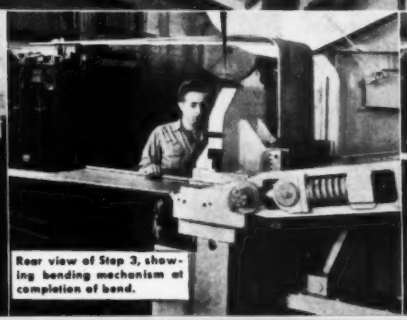
Sheet is then inserted in tangent bending device and the first top corner bend is made. Buckling or wrinkling of flanges at the corner radius is avoided.

•

Sheet is moved further into the machine and second corner is formed. Once machine is set up, duplication of parts is automatic and very accurate.

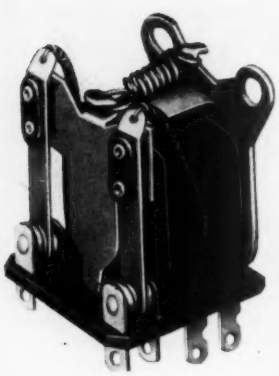
3





Rear view of Step 3, showing bending mechanism at completion of bend.

Same view except that bending mechanism has been returned to starting position.



Small Magnetic Relays

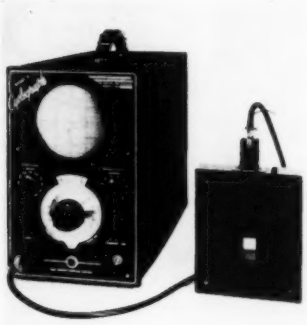
Ward Leonard Electric Co., 31 South St., Mt. Vernon, N. Y.

Designed for remote control and automatic circuit applications where space is very limited, these relays measure $1\frac{1}{8}$ x $\frac{5}{8}$ x 1 in. Mounting base is metal and terminals are of the solder type. Suitable for operation on 115 v, 60 cycle a-c or 32 v d-c circuits, relays are supplied with silver contacts rated at 3 amp, 115 v, 60 cycle maximum for non-inductive loads.

Speed Reducers

Boston Gear Works, Quincy, Mass.

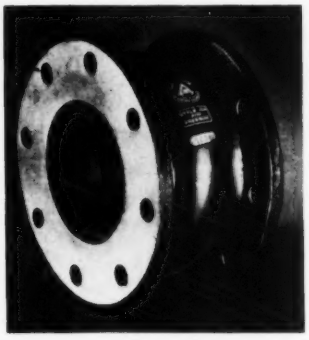
Type TAN speed reducer replaces type TA Reductor. These 8 models have heavier gearing and larger shafts than their predecessors with speed reduction ratios ranging from 10 to 80. At 1,800 input rpm, hp output ratings range from $\frac{3}{32}$ to $1\frac{1}{4}$, and torque ratings vary from 437 to 789 lb-in. A vent valve is incorporated in the filter plug on top of the assembly, and the worm gear is made integral with its shaft. Except for shaft sizes, the reducer is interchangeable with the TA unit, having the same shaft centers and mounting dimensions.



Metal Analyzer

J. W. Dice & Co., 191 River Rd., Grand View-on-Hudson, N. Y.

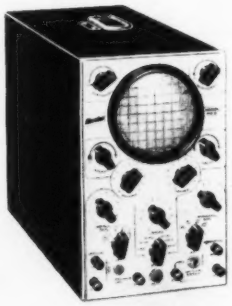
Model C Cyclograph is a portable instrument operating on the core loss principle for non-destructive metallurgical examinations and sorting of metal parts. A recorder output element is provided with the instrument for internal stress analysis. Because the test frequencies range from 2 to 200 kw, the unit can also be used for checking structure, hardness and case depth of metal parts. Model weighs 50 lb, operates on 115 v, 40-60 cycle with power consumption of 70 watts.



Rubber Expansion Joints

The Garlock Packing Co., Palmyra, New York

Expansion joints are made of a rubber compound combined with piles of cotton duck. The body is reinforced with steel wire. For services where oil resistance is necessary these joints are available with neoprene liners. Flexibility is provided by a central arch in the body of the joint located midway between the two flanges. This arch flexes with expansion and contraction of the piping to absorb stresses and strains in line. Flanged joints are available in sizes from 2 to 72 in. and in styles designed for pressure or vacuum applications.



Cathode Ray Oscillograph

The Hickok Electrical Instrument Co., 10544 Dupont Ave., Cleveland 8, Ohio

Model 195 B contains a 5 in. tube with calibrated screen, sinusoidal sweep with phasing control, FM sweep oscillator, wide band vertical amplifiers with frequency range up to 1 megacycle, intensity modulator and return eliminator. Oscillograph is designed as a general purpose instrument for research and development work, and for analysis of transient phenomena in mechanical and electrical devices. The high-gain amplifies are sensitive to 0.015 v per inch. Instrument requires power of 105–125 v, 50–70 cycles, and consumes 50 w at 115 volts.

Stainless Steel Paint

The Lockrey Co., Plastics Div., College Point, N. Y.

This material is a form of paint which can be applied to surfaces by brush or spray. It consists of stainless steel flakes incorporated in a mixture of vinylic copolymer resins with a volatile thinner to bring it to brushing consistency. Mixture dries at room temperatures in any time from a few seconds to an hour depending on con-

Added value for your design . . .
Piping from the CRANE line

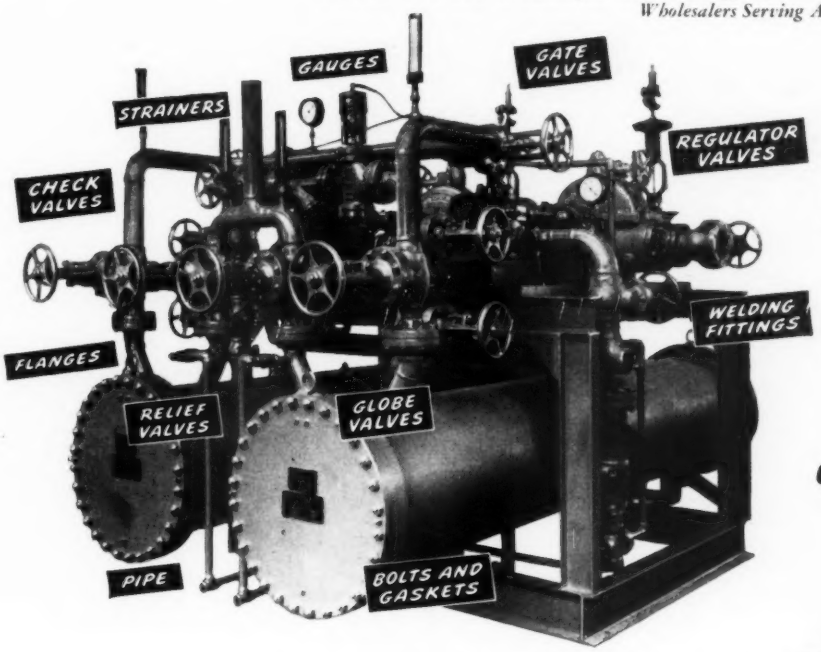
ONE
SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

When the piping on your design is Crane, buyers recognize it as a sign of added value. Why? Because they know from experience that Crane Quality stands for **High Quality**—unsurpassed today as for more than 90 years.

This Fuel Oil Pump and Heater Unit, for example, bears the stamp of added value—Crane—on all valves, fittings, accessories and pipe. Here, piping equipment is used to control the flow of steam and heated fuel oil. But regardless of fluids to be handled, the complete Crane line has the piping you need . . . conveniently listed in one catalog.

Because Crane supplies everything, specifying from this **Single Source of Supply** simplifies all piping procedures. It facilitates buying and storekeeping, for instance. And putting **Undivided Responsibility** for materials on Crane results in smoother assembly operations; assures better control of factory schedules.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Illinois. *Branches and Wholesalers Serving All Industrial Areas.*



Fuel Oil Pumping and Heating Unit by A. M. Lockett & Co., Ltd., New Orleans. Completely equipped by Crane.

IN STEEL VALVES *for oil or oil vapor service as on fuel pumps, Crane supplies gates, globes, angles and checks, cast and forged, in pressure classes for all applications. Shown here, Crane No. 143½X Cast Steel Globe Valve with welding ends for maximum temperatures of 500 deg. F. Exelloy to Exelloy seating. Sizes: 2 in. and larger. See your Crane Catalog, p. 324.*

EVERYTHING FROM . . .

VALVES · FITTINGS
PIPE · PLUMBING ·
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

ditions of application and thickness of coat. This coating will withstand intermittent exposure to temperature up to 350 F, but high temperatures or prolonged exposure will cause yellowing and final disintegration. Tests of six months duration with outdoor exposure show no signs of weathering or yellowing. Immersion for two week periods in salt and fresh waters indicate no measurable water absorption, either by coating or material coated. Metallic paint is bluish gray, but various color dyes can be added without affecting the material's properties.

Corrosion Inhibitors

Rotometals, Inc., 980 Harrison St., San Francisco 7, Calif.

Corrosion inhibitor zinc-rods are fitted with standard pipe plug ends which screw into heat exchangers, water systems of diesel engines, refrigerators, industrial radiators, piping or other hydraulic equipment. Since zinc has higher electro-chemical potential than metals to be protected from corrosion, oxygen and other corrosive causations consume the zinc in preference to the materials from which the hydraulic equipment is made. Zinc rods come in $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$ and 1 in. diameters.

Fire-Resistant Lubricant

Monsanto Chemical Co., St. Louis, Mo.

A pressure transfer medium known as Skydrol has been developed. In performance tests this fluid, although oily, showed that it would not feed a fire as ordinary oils will. Also in a similated hot manifold test it was shown that Skydrol did not burn as it flowed down a pipe heated to 1300 F. Autogenous ignition point is 1050 F. Fluid operates with pressures up to 5,000 psi with negligible loss of film strength, and will not attack aluminum, magnesium, aircraft bearing alloys, copper or steel. It has viscosity index of 160 and ASTM pourpoint of below —60 Fahrenheit.

Fluxmeter Calibrating Unit

General Electric Co., Meter & Instruments Div., Schenectady 5, N. Y.

Device for calibrating GE indicating flux-meter and fluxmeter-type photoelectric recorder. Unit consists of Alnico magnet rod and housing with a search coil which is tapped and connected through a selector switch and terminal post. To operate, unit is connected in series with the search coil for making flux measurement, and switch is set at the desired value of flux-linkages. When magnet is removed from housing, desired flux-linkage action takes place. It is possible to calibrate fluxmeter so that each millimeter of scale reading will be equivalent to a known value of flux linkages.

Free-Machining Alloy Steel

Joseph T. Ryerson & Son, Inc., Box 8000-A, Chicago 80, Ill.

Known as Rycut, this is a 0.50 carbon chrome-molybdenum steel that is said to cut down machining time 25 to 50 percent as compared with standard alloys. Specimens of 2½ in. bar stock which have been oil quenched and tempered have a BHN of about 341, tensile strength of 140,000 psi, yield point of 120,000 psi and elongation in 2 in. specimen of 15 percent. Alloy steel is available in flat sizes from ¾ x ¾ in. to 3 x 6 in., in diameters from ½ to 8 in. and square sizes up to 6 inches.

Hydraulic Gages

A. Schrader's Son, Brooklyn 7, N. Y.

Dial gages in 9 different sizes to record pressures from 5 to 5,000 psi operate on a direct action principle. A piston inside the mechanism rises against a resisting spring; this movement is relayed to the dial indicator. Construction of these gages are such that they can withstand overloads and shock. Overall length is 10¾ in. and dial has 6¼ in. outside diameter.

Smoke Indicator

Brooke Engineering Co., Philadelphia, Pa.

Photo-electric smoke indicator has been adapted to control over-fire air to lessen smoke in coal-burning furnaces. A light beam projected across a boiler or furnace flue shines on a photo-tube which measures smoke density. When this density increases beyond a certain amount, a red warning light flashes

FAIRBANKS-MORSE

motorgear

Simplify your slow speed DRIVES

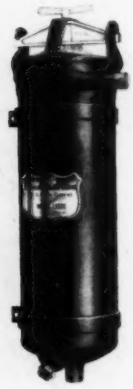
The new Fairbanks-Morse Motorgear which combines double reduction, helical gears with the well-known Axial Air Gap Motor *is a complete slow speed unit — more compact than the average electric motor alone!* Wherever you are using a slow-speed drive in standard ratios up to and including 10 h.p., the Motorgear will save space and weight, minimize servicing and improve the appearance of the driven unit. Send for a Motorgear bulletin. Fairbanks, Morse & Co., Chicago 5, Illinois.

FAIRBANKS-MORSE

A name worth remembering

DIESEL LOCOMOTIVES • DIESEL ENGINES • PUMPS • SCALES • MOTORS • GENERATORS
STOKERS • RAILROAD MOTOR CARS and STANDPIPES • FARM EQUIPMENT • MAGNETOS

and a time relay closes. This starts over-fire air jets. These jets remain on for the period of time for which time relay circuit is set. Manual push-button control is also provided, and modulated control of continuous, over-fire air can be furnished if desired.



Oil and Fuel Filter

W. G. B. Oil Clarifier Inc., Kingston, N. Y.

Model CT-100 is a filter suitable for lube or fuel oil clarification. Side inlet at the upper end gives a washing action around the filter cartridge which by centrifugal force causes matter heavier than oil to be thrown away from the cartridge and settle in the sediment chamber. Filtering area is almost 272 sq in. when used with lube oil, and 238 sq in. when fuel cartridges are used. When filter is installed in fuel lines, the inside governing orifice is removed to allow for free flow around the fuel cartridge. The CT filter is 24 in. long and 6½ in. dia with ¾ in. ID outlet and inlet tubes.

Styrene Resin Coating

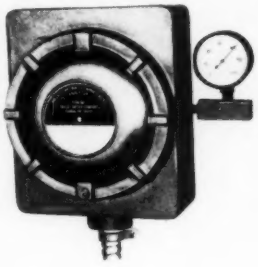
American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N. Y.

Styrene-alkyd copolymer resin in petroleum spirits solution, known as S-101-1, is produced as a white baking enamel or as air drying enamel in white, black, red, blue or green. The air drying enamels are dust free within 15 to 30 min of application and can be applied with either brush or spray. Coatings are non-reactive and have stability with all normal pigments including basic types such as zinc oxide.

Laboratory Furnace

Pereny Equipment Co., 893 Chambers Rd., Columbus 12, Ohio

Furnace CB-55 offers heat ranges from room temperature to 2,500 F for continuous operation, and flash firings up to 3,000 F. Heat is distributed from six Globar elements, three above and three under the chamber. All operating controls are on the front panel, and heating is controlled by an indicating and controlling pyrometer, a current input meter and a 36-tap transformer. Instrument also contains an interlock which prevents manipulation of the transformer switches under load, a circuit breaker and a safety pilot light which warns of any interruption to furnace operation. Power required is 230 v, 60 cycle, single-phase, with control from 3.5 to 11 kilowatts.



Gas Analyzer

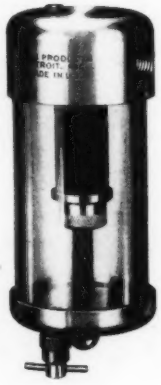
Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio

To determine the amount of one gas in another, the gas analyzer measures rate at which heat is conducted by the gas being sampled. Mounted in an explosion-proof case, analyzer is unaffected by ambient temperature or voltage variations. The gas sample must be free of entrained moisture, maximum static pressure is 100 psig and the flow for best response is 100 cu in. per min. Instrument can be used in conjunction with Recorder Type WS, and accuracy then is 1 percent of the full scale deflection. Power required is 30 w, 100/130 v, 60 cycle regulated frequency.

Blue Print Cabinet

Empire Development Corp., 209 Union Trust Bldg., Washington, D. C.

Steel cabinets, measuring 20 x 30 x 48 in., are available in brown, green and gray, and accommodate up to 1,000 prints. Drawings hang vertically on extension rods and, any one print or drawing can be removed without disturbing the others. The front and top of cabinet can be opened so that prints can be removed or inserted in their indexed positions.



Air Line Filters

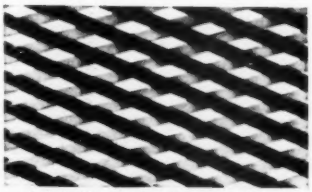
M-B Products, 130-34 E. Lavned St., Detroit 26, Mich.

Air line filters available in N.P.T. sizes of ¼, ⅜, ½, ¾ and 1 in. with bowl capacities of ½ or ¾ pints and ⅔ quarts. Transparent plastic bowls make it possible to see when the filter element should be cleaned. This plastic material withstands temperatures up to 150 F and a burst test of 500 lb. Filtering element functions on the edge filtration principle and removes solids 10 microns and larger.

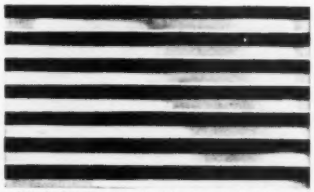
Paradise *for* Designers

☆ ☆ ☆ ☆ ☆ ☆ ☆ ☆

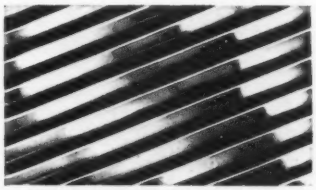
NICKELOID PRE-PLATED METALS SHOWN IN GREAT ARRAY OF PATTERNS, FINISHES



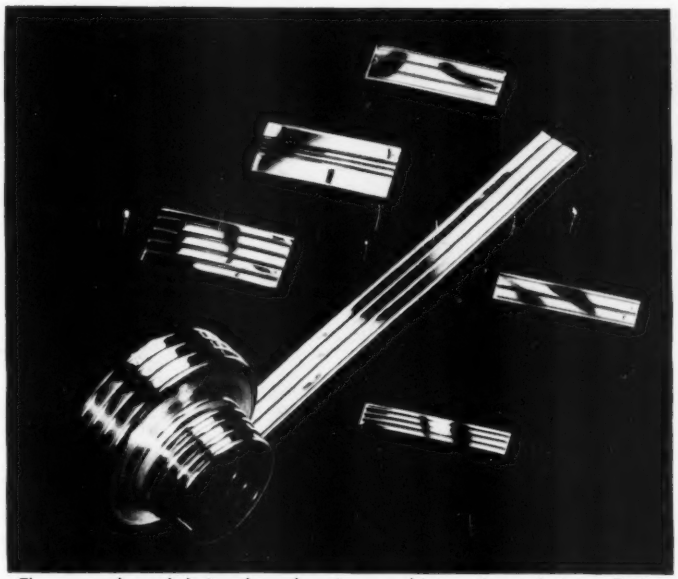
Nickeloid Metals Diamond Crimp



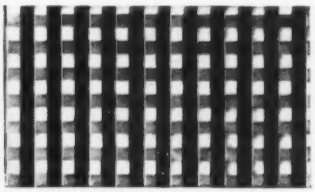
Nickeloid Metals Horizontal Crimp



Nickeloid Metals Diagonal Crimp



The new embossed design shown here in several interesting variations. Design can be embossed (raised) or intaglio (depressed).



Nickeloid Metals Square Crimp

Product designers need not be limited to the use of unrelieved bright surfaces of plated metals in adapting Nickeloid Metals to trim or functional use in their new designs. These metals are offered in various interesting stripes, crimps, and embossed designs.

Thus, if the product surface to be trimmed is already large and unrelieved, it may be that a beaded trim will brighten the product and relieve the monotony of large, unbroken surfaces. Moreover, patterns many times have a functional use: such as the use of diamond crimp or square crimp to improve diffusion of light (light reflectors) or of heat (room heaters).

Nickeloid Metals are furnished in durable pre-plated finishes of Chromium, Nickel, Brass or Copper in sheets and coils — base metals of steel, zinc, brass, copper, or aluminum. The base metal can be chosen from the standpoint of one or more of the following factors: cost, resistance to heat, rust-resistance, availability, workability.

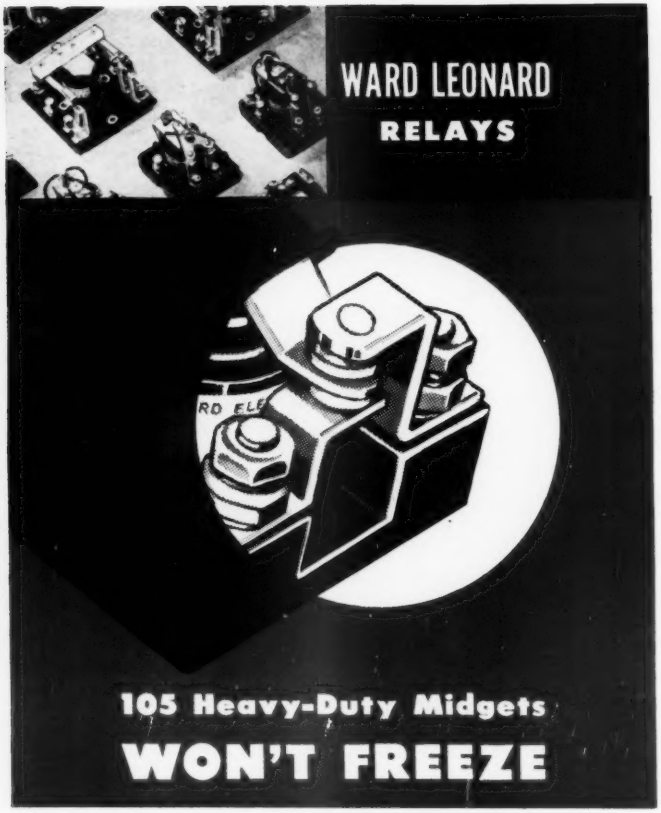
Send for our New

Sampler

Containing actual metal samples of many of the finishes and patterns which are available.

AMERICAN NICKELOID COMPANY
PERU 4, ILLINOIS

A few of the gleaming, interesting patterns in Nickeloid Metals which the product designer can adapt to his needs.



because contacts get a GENEROUS WIPE

Unique spring suspension adds a self-cleaning action to the heavy, silver-to-silver contacts of Ward Leonard's 105 Heavy-Duty Midget Relays. These features make them self-aligning, too.

Use Ward Leonard 105 Midgets on jobs normally requiring heavier relays.

Write for Relay Catalog. Ward Leonard Electric Co., 63 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY
Result-Engineered Controls
RESISTORS · RHEOSTATS · RELAYS · CONTROL DEVICES

NEW BOOKS

Proceedings of The Society For Experimental Stress Analysis

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS. 137 *pages*, 8½ x 11 *in. Published by Addison-Wesley Press, Inc., Kendall Square, Cambridge 42, Mass.* $6.

This annual volume includes these papers and some discussions. Extensive bibliographies are included with many of them. Sangdahl, Aul, and Sachs, "An Investigation of the Stress and Strain States Occurring in Bending Rectangular Bars"; Leven, "A New Material for Three-Dimensional Photoelasticity"; Monchor, Lissner, and Lipson, "Long-Time Electric Strain Gage Measurements on Concrete Reinforcing Rods at the Packard Proving Grounds Test Track"; Weller and Shepard, "Displacement Measurement by Mechanical Interferometry"; Frocht, "Some Simplifications in the Numerical Solution of Laplace's Equation with Special Applications to Photoelasticity"; Mehaffey, Van Scoyoc, and Schover, "A Direct Coupled Amplifier for Recording Dynamic Strain"; Armstrong, "Shock Testing Technology at the Naval Ordnance Laboratory"; Mantle and Dolan, "A Photoelastic Study of Stresses in U-Shaped Members"; Coolidge, "An Investigation of the Mechanical and Stress-Optical Properties of Columbia Resin, CR-39"; Lee, Meadows, and Taylor, "The Photoelastic Laboratory at the Newport News Shipbuilding and Dry Dock Company"; Durelli, "Discussion of Above Paper"; Cornell, "The Collapse of Long Cylindrical Shells under External Pressure"; Leal, Bisplinghoff, and Pian, "Studies of Transient Stresses in Airplane Model Wing during Drop Tests"; Brewer, "The Equilateral Fleximeter"; Twyman, "Interpretation into Stresses of Post-Yield Strains up to Two Percent."

Simplified Design of Structural Timber

HARRY PARKER, M. S., *Professor of Architectural Construction, University of Pennsylvania. 212 pages* 5 x 7¾ *in. Published by John Wiley & Sons, Inc., Fourth Ave., New York, N. Y.* $3.25.

The author has endeavored to explain as simply as possible the methods commonly used in determining proper timber sizes. It covers primarily wood members that support loads in buildings. Explanations of basic principles of mechanics involved in the design

are given, and numerous safe load tables have been included so that selection of proper sizes of members for given conditions can be made quickly.

Stress tables, properties of sections and tabulations of technical information pertinent to timber construction are included. It is assumed that those who use this book have no previous training. A knowledge of highschool arithmetic and algebra is all that is necessary to understand the mathematics used.

Chapters cover: Characteristics and Classifications of Wood; Unit Stresses; Working Stresses for Structural Lumber; Properties of Sections; Bending Moments and Shear; Shearing Stresses in Beams; Deflection of Beams; Design of Beams; Joists and Rafters; Plank and Laminated Floors; Timber Columns; Bolted Joints; Timber Connectors; Truss Design; Combined Bending and Axial Loading; Trussed Beams; Design of Purlins; Compound Beams; Stud Walls.

Glass the Miracle Maker

C. J. PHILLIPS, *Consultant at Pittsburgh Plate Glass Company* 429 *pages*, 6 x 9 *in. Published by Pitman Publishing Corp., 2 W. 45th Street, New York* 19, *N. Y.* $6.

This second edition presents an up-to-date survey of all phases of glass and the glass industry. It includes the history of glass, current statistics, physics and chemistry of the materials, methods of manufacture, and applications in the home, throughout industry, and to science and research.

The volume is of particular interest to glass technologists and glass-plant workers, to architects, engineers, designers, and executives in those industries where glass is used. Graduate and undergraduate students studying ceramics and glass technology will find the book to be of definite value.

In this new edition are chapters on the mechanical properties of glass, applications, lamp-working and glass-to-metal seals.

New and additional information is also included on mechanical strength, dielectric absorption, volume and surface resistivity, dielectric constant, power factors, loss factor, dielectric strength, bent glass for airplanes and automobile windows, silicones and glass-plastics combinations.

Chapter titles are a sufficient description of the coverage of statics, kinematics, and dynamics. They include: Discrete Coplanar Forces; Conditions of Equilibrium; Distributed Forces; Trusses and Cables; Beams; Friction; Space Forces; The Method of Work; Kinematics of a Point; Dynamics of a Particle; Kinematics of Plane Motion;

because contactor parts are ACCESSIBLE

Removing a single key permits the entire moving contact assembly to be withdrawn for inspection of all main silver contacts, both moving and stationary.

And it's easier to replace main stationary contacts, too, due to the use of individual spring retaining clips.

Write for Bulletin 4110. It fully describes Ward Leonard's new Size 1, 2 and 3 across-the-line, non-reversing AC magnetic starters. Ward Leonard Electric Co., 63 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY
Result-Engineered Controls
RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

Where electrical contact is required to a moving part, laminated precious metal rings offer unusual operating characteristics at a real saving in cost over solid precious metal rings.

Silver or Gold, or Platinum, or Palladium, or their alloys, bonded to the required base metal, such as copper or bronze alloys, make possible . . .

- . . . **Uniform contact resistance**
- . . . **Low noise level**
- . . . **Selected temper for essential wearing quality**
- . . . **Mechanical strength**
- . . . **Corrosion resistance**

These rings are now being used in special electric motors, calculators, and computators, Radar, and fire control instruments, potentiometers, and other electro mechanical devices.

Our engineers will be pleased to make recommendations to meet your requirements. We would also be pleased to submit quotations to cover your specifications.

START RIGHT with *Makepeace* PRODUCTS

SHEETS • WIRE • TUBING • SOLDERS • FABRICATED PARTS AND ASSEMBLIES

D. E. MAKEPEACE COMPANY

Main Office and Plant, Attleboro, Massachusetts

NEW YORK OFFICE 30 CHURCH ST. • CHICAGO OFFICE 55 EAST WASHINGTON ST.

Moments of Inertia; Dynamics of Plane Motion; Work and Energy; Impulse and Momentum; Relative Motion; Gyroscopes.

Problems and answers are included in separate appendices.

Machine Design

PAUL H. BLACK, *Professor of Machine Design, Cornell University.* 344 *pages,* 6 x 9 *in. Published by McGraw-Hill Book Co., Inc.,* 330 *W. 42nd St., New York* 18, *N.Y.* $4.

A basic textbook for courses of college grade in general machine design, and a reference book of established modern practice. It is unique in its excellent consideration of stress concentration in machine members, causes and prevention. The chapter on surface finish and its relationship to friction and wear is unusual in such a text, and to be commended. Chapters cover: Introduction; Materials and Processes; Machine-design Computations; Loading and Induced Stresses; Stress Concentration in Machine Members; Allowable Stresses; Members That Fail by Buckling; Mechanical Fabrication; Detachable Fastenings; Springs; Pressure Cylinders; Translation Screws; Shafting; Belt Drives and Hoists; Power-transmission Chains; Shaft Couplings; Clutches and Brakes; Spur and Parallel Helical Gears; Gears for Nonparallel Shafts; Surface Finish, Friction, and Wear; Sliding Bearings and Lubrication; Ball and Roller Bearings; Metal Fits and Tolerances; Vibration and Vibration Control.

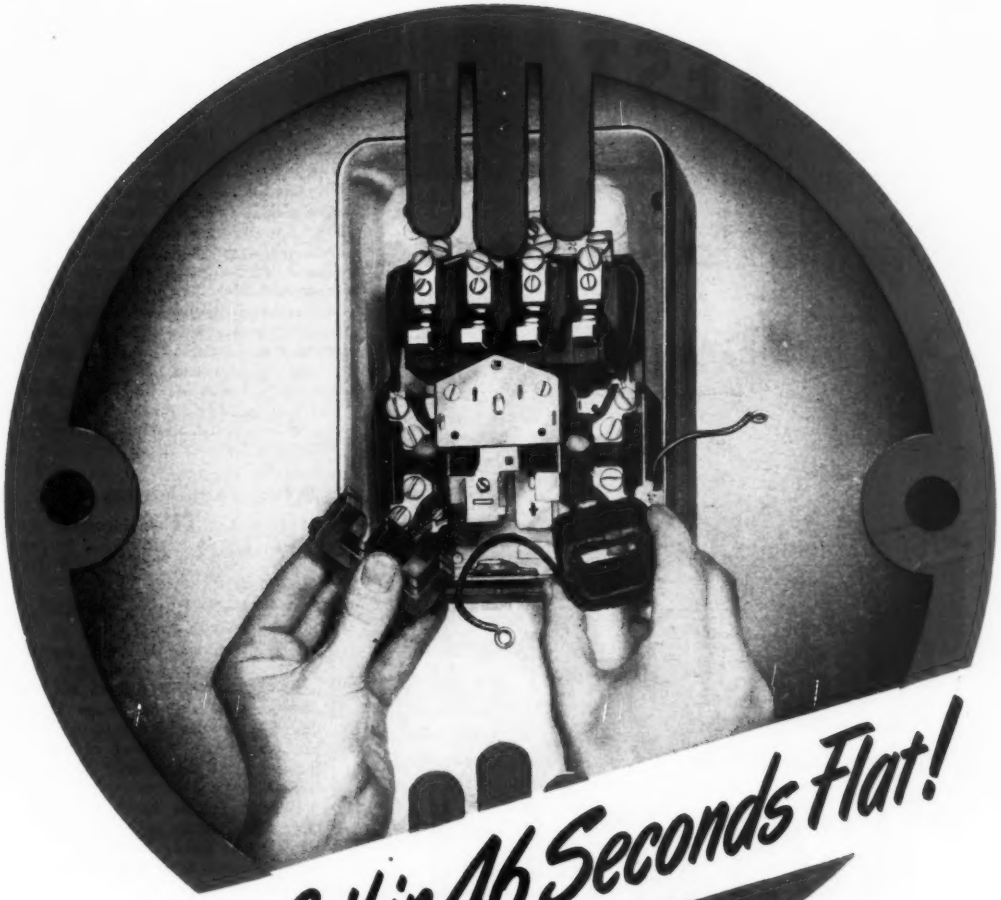
The author has many references throughout each chapter. These are drawn from current journals, transactions and technical periodicals, so that the reader can consult the reports of technical progress. This is an unusually effective machine design text.

Mechanics of Materials

GLENN MURPHY, *Professor of Theoretical and Applied Mechanics, Iowa State College* 310 *pages* 6 x 9 *in. Published by Irwin Farnham Publishing Co.,* 3201 *South Michigan Ave., Chicago* 16, *Ill.* $4.50.

The purpose of this text book is to assist the student in his development of an understanding of the behavior under load of structural members and machine parts constructed from the common engineering materials. The book directs his attention to those principles that have been found useful in explaining observed phenomena, and acquaints him with standard procedures of analysis.

Principles of statics, characteristics of the geometry of the loaded mem-



Change Coil in 46 Seconds Flat!

Change is FASTEST, EASIEST with Federal Noark Motor Starter

IT'S ALMOST "PRESTO, CHANGE!" replacing a coil in Federal Noark Motor Starters. Only three quick operations to get the old coil—three more, in reverse, to insert the new one. Federal design is the simplest, fastest on the market today. All parts readily accessible from the front. Saves time, effort and money.

What's more, there's almost no chance for trouble in Federal Noark Motor Starters. There's only one moving unit and that *rides on ball bearings*—an exclusive Federal feature!... Important, too, Federal permits the choice of getting automatic or manual reset instantly... simply turn a knob and you've the type of overload protection that you want.

Order Federal Noark Motor Starters from your Federal Distributor. And write us for free copies of the "Federalog" and "Simplified Motor Control" giving full descriptions. Federal Electric Products Company, 50 Paris St., Newark 5, New Jersey.

FEDERAL NOARK

MOTOR STARTERS

Complete line of Federal Electric Products includes Motor Controls, Safety Switches, Service Equipment, Circuit Breakers, Panelboards, Switchboards, Bus Duct ★ Sales offices in principal cities

TEST LISLE *Magnetic* DRAIN PLUGS

"Wild Metal"

● The powerful magnet in the Lisle *Magnetic* Drain Plug attracts and holds the abrasive "Wild Metal" particles that flake off moving parts and circulate in the lubricant. You'll be surprised when you actually see the amount of "Wild Metal" that a Lisle *Magnetic* Plug will trap. And you'll be *convinced* when you see how the removal of this abrasive metal prolongs the life of precision tolerances. Specify Lisle *Magnetic* Plugs in place of ordinary drain or fill plugs in the engine, gear housing, or hydraulic system in the equipment you make.

Sample Magnetic Plugs, for testing purposes will be furnished without charge. Write for interesting application data.

LISLE *Corporation*

811 EAST MAIN STREET, CLARINDA, IOWA

MAKERS OF LISLE RIDGE REAMERS AND OTHER FAMOUS AUTOMOTIVE TOOLS

ber, and the effects of the properties of the material are emphasized in considering each type of stress condition.

Discussion is included of those topics that normally comprise a first course in mechanics of materials, strength of materials, or resistance of materials. The customary formulas are also developed. Some elementary aspects of design applications are included.

Chapter heading topics include: Stress, strain, and axial loading; joints and connections for axially loaded members; torsion; stresses in flexural members; deflection of flexural members; statically indeterminate beams; columns; combined loads, and dynamic and repeated loads.

A generous set of drill problems are included to help the student apply and master the principles set forth in the text.

Rotary Valve Engines

MARCUS C. INMAN HUNTER. 216 *pages,* 5½ x 8½ *in. Published by John Wiley & Sons, Inc.* 440 *Fourth Ave., New York* 16, *N.Y.* $5.

In this book, the author traces the history of the development of the rotary valve and illustrates the numerous applications of rotary and semi-rotary systems to both old and new systems. At each stage in the design, he shows how to combat friction, which is the chief obstacle to the successful performance of the rotary valve.

Because of the increasing importance of the rotary valve, the author's views on its merits are of more than average interest to engineers and engineering students.

The discussion covers principles of design, port areas and valve diameters for four-cycle engines, drive gear and application of the rotary valve to the engine, Burt McCollum semi-rotary sleeve valve engine, modern rotary-valve systems, the Rotol auxiliary generating plant for aircraft, German disk-valve engines, claims for the rotary valve and the future trend.

More than a hundred illustrations are included in the book, most of which are line drawings.

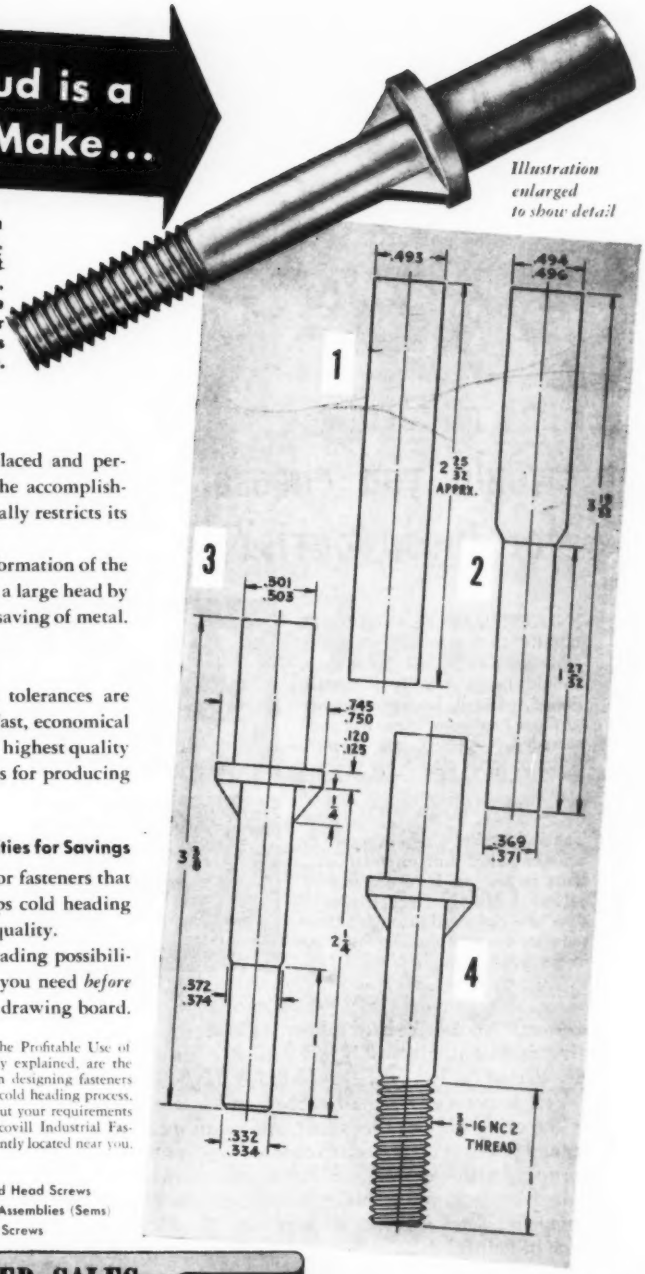
Aerodynamics of a Compressible Fluid

HANS—WOLFGANG LIEPMANN *and* ALLEN E. PUCKETT. 6 x 9¼ *in.,* 262 *pages. Published by John Wiley & Sons, Inc.,* 440 *Fourth Ave., New York, N. Y.* $4.

The material presented in this book is designed to furnish the reader with a background of fundamentals sufficient to enable him to understand or,

This Copper Stud is a Tough Part to Make...

Tough? Yes, impossible to make in any practical way except by cold heading. Scovill turns it out in highest quality, fast and at low cost. Examples like this of the art of cold heading demonstrate for your benefit a wide range of possibilities in the hands of Scovill craftsmen.



Intricate Shapes *Are* Practical

Note the sharp-cornered, accurately placed and perfectly formed *lugs* under the flange. The accomplishment of this essential feature automatically restricts its manufacture to cold heading.

Cold heading technique permits the formation of the comparatively small body diameter and a large head by extrusion. This results in a tremendous saving of metal.

Consider These Inherent Advantages

Cold heading conserves metal. Close tolerances are held—fewer operations are necessary. Fast, economical production is assured. The product is of highest quality and finish, of greater strength, the tools for producing it are a minor item of expense.

Scovill Experience Opens New Possibilities for Savings

Take another look, now, at your parts or fasteners that are not made by cold heading. Perhaps cold heading offers savings, together with highest quality.

And, in particular, talk over cold heading possibilities with us on new parts or fasteners you need *before* definitely putting them down on your drawing board.

Send now for "A Guide to the Profitable Use of Cold Heading." Here, clearly explained, are the advantages and limitations in designing fasteners and component parts for the cold heading process.

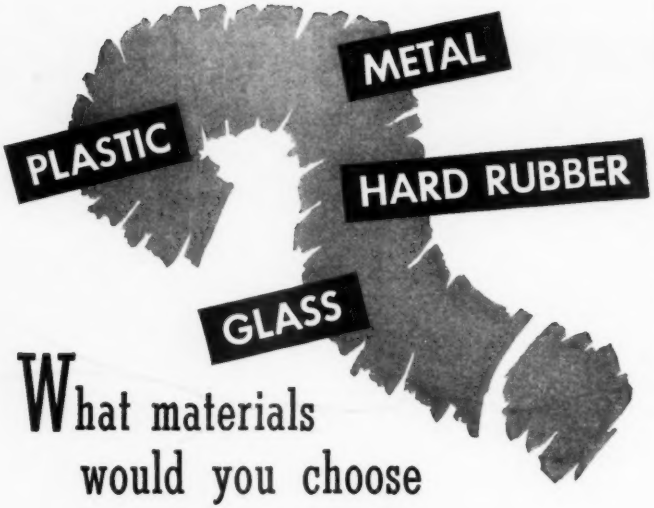
We will be glad to work out your requirements with you. Note below the Scovill Industrial Fastener Representative conveniently located near you.

Special Cold Headed Parts • Phillips Recessed Head Screws
Clutch Recessed Head Screws • Washer Screw Assemblies (Sems)
Tapping Screws • Standard Machine Screws

INDUSTRIAL FASTENER SALES
WATERVILLE DIVISION

SCOVILL MANUFACTURING CO.
Waterville 48, Connecticut

New York, Chrysler Building • Detroit, 858 Maccabees Building, Woodward Ave. at Putnam • Chicago, 222 West Adams Street
Los Angeles, 2627 South Soto Street • Cleveland, Terminal Tower Building • San Francisco, 434 Brannan Street



What materials would you choose for these parts?

1 **INDUSTRIAL FLASHLIGHT CASE:** Must be tough, good-grip, non-corrosive, oil-resistant surface. Should be electrically insulated. Plated, painted, imitation leather surfaces had been tried, but they corroded, chipped, or peeled. What material would *you* use?

2 Tapered gasket ring, exposed to acids, alkalies and essential oils, must impart no taste or odor to solutions. Must be free from "cold flow" for tight seal through a temperature range from 0° to 100° F. What material would *you* pick?

Answers: No. 1—Ace hard rubber, molded around brass tube, gives insulated, practically indestructible flashlight. No. 2—Ace Parian (polyethylene) is ideal for this gasket ring.

Yes, sometimes it's hard rubber, and sometimes it's one of the other plastics that's best. Ace, with many hard rubber and plastics compounds to choose from, is fully equipped to supply whatever you need. If you want this kind of impartial advice from your molder, select American Hard Rubber Company. Send for free 60-page Ace Handbook—a gold mine of helpful data.

ACE
Since 1851
HARD RUBBER and OTHER IMPORTANT PLASTICS
AMERICAN HARD RUBBER COMPANY
11 MERCER STREET • NEW YORK 13, N. Y.

at least to systematize the observed compressibility effects, and also to enable him to approach intelligently the more mathematical literature on the subject. This double purpose not only sets the pattern for the material that has been included, but also dictated the book's division into two parts.

The first part deals with One-Dimensional Motion of a Compressible Fluid and includes the following: Basic thermodynamics, equations of motion in one dimension, isentropic channel flow, shock waves, applications to channel flow and optical methods of flow observation. Part two covering Two and Three-Dimensional Motions of a Compressible Fluid is broken down into: Equations of motion, small-perturbation method, applications of the small-perturbation method, hodograph methods, method of characteristics, effects of viscosity and airfoils in high speed flow.

Emphasis is placed almost exclusively upon the derivation and the meaning of the fundamental aerodynamics relations. There has been no attempt to produce a standard classroom textbook. No problems are given, but a few practical examples are worked out.

A short table of references at the end gives a list of papers on various aspects of this subject.

Cathode Ray Tube Displays

Edited by THEORDORE SOLLER, MERLE A. STARR *and* GEORGE E. VALLEY, JR. 6¾ x 9¼ *in.*, 746 *pages. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York* 18, *N. Y.* $9.

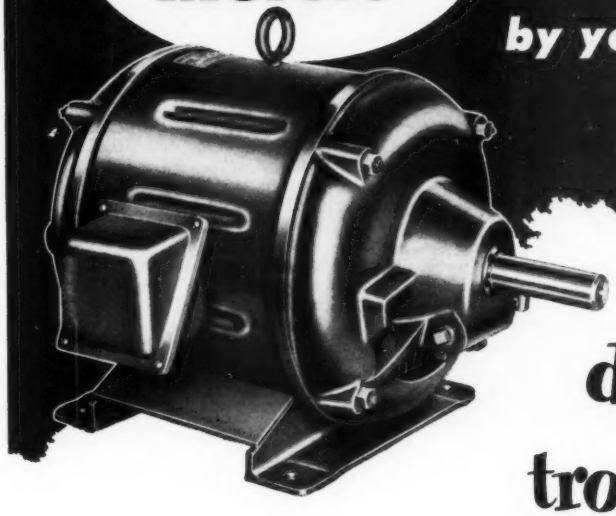
This book is one of seven related volumes of the Massachusetts Institute of Technology Radiation Laboratory Series. It describes solutions to problems involved in the application of cathode-ray tubes to radar displays and to test equipment. Although the design of the tubes themselves is not considered in detail, operating characteristics of the tubes and of their auxiliary equipment, as well as the characteristics and construction of their screens, are discussed at length. A number of means for producing sweeps is given both for electrostatic-and magnetic-deflection tubes. Great emphasis is placed on sweeps that progress linearly with time.

Because of the close relation between the function of a radar set and the design of its display system, frequent reference has been made to specific radar applications of cathode-ray tubes. The introductory chapter presents a general description of the problems peculiar to radar so that the mo-

Wagner STEEL-FRAME Motors

Proved

by years of service!



quiet... dependable... trouble-free!

Since 1930, when Wagner started manufacturing steel-frame drip-proof motors, they have been *proved*—by years of hard usage in industry after industry.

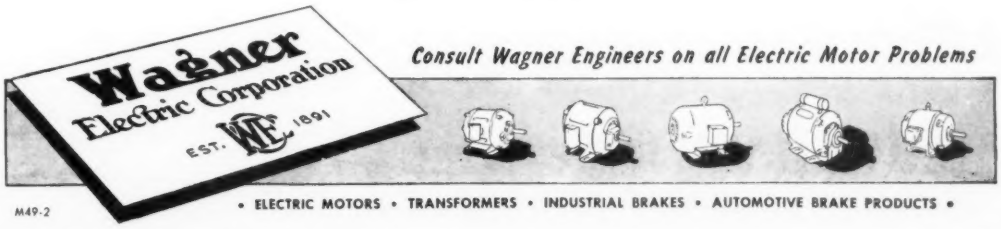
Today this time-tested design is available in polyphase motors through 326 frame size. The motor frames are formed of heavy rolled steel, shaped to accurately center the stator core and to provide passages for adequate ventilation. An auxiliary fan draws in air through the openings in the front endplate, forces it through these passages and out through the endplate openings on the drive end. Heat is effectively carried off from all parts of the motor.

These motors are available with either sleeve or ball bearings. They are completely drip-proof when mounted in the normal horizontal position, and by rotating the endplates are still drip-proof in the sidewall or ceiling horizontal positions.

Bulletins give full information on the complete line of Wagner Motors. Twenty-nine branches, located in principal cities, are ready to assist you whenever you have a motor problem. In addition, almost 500 authorized motor repair shops provide speedy, nationwide service facilities.

Wagner Electric Corporation

6406 PLYMOUTH AVE., ST. LOUIS 14, MO., U. S. A.



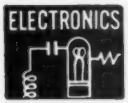
Consult Wagner Engineers on all Electric Motor Problems

M49-2

• ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE PRODUCTS •

FLEXIBLE SHAFTS

Wherever power drives or remote control are required, you can depend upon us to produce the Flexible Shafts that will meet the exact specifications. We have years of experience in manufacturing flexible shafting for all types of industry. If we do not have what you require in stock, we can make shafts to your specifications. Our engineers will be glad to work out your problems without obligation.



Many new uses for flexible shafts that carry power around any corner have been developed by our engineers . . . in machine shops, electronic, automotive, aircraft, in all industries where power drives or remote control are required. *Write for Manual P. E.*

CIRCLE 11

F. W. STEWART MFG. CORPORATION

4311-13 RAVENSWOOD AVE. CHICAGO 13, ILL.

WEST COAST BRANCH: 431 Venice Blvd.; Los Angeles 15, Cal.

This is how STROM BALLS are born

A heading machine cutting sections from heated steel rods and compressing them in a die to a rough spherical shape.

The steel is carefully chosen and inspected, even before it gets to the heading machine. After being "born" here, balls are carefully "brought up," through a long series of grinding and lapping operations, to the unbelievably high standards of finish, sphericity and precision which have made Strom Metal Balls the standard of Industry. Strom Steel Ball Co., 1850 South 54th Avenue, Cicero 50, Illinois.

Strom BALLS Serve Industry

Largest Independent and Exclusive Metal Ball Manufacturer

tivation of circuit design can be understood. Several chapters elaborate on functional circuits used in building up a display system, while the final chapters show how these parts can be synthesized into complete systems.

Engineering Materials

ALFRED H. WHITE, *Professor Emeritus of Chemical Engineering, University of Michigan. Second Edition, revised. 686 pages, 6½ x 9¼ in. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 18, N. Y. $6.*

This text can be useful to practicing engineers as well as to engineering students. It is a systematic presentation beginning with the fundamental properties of solids and terminating with chapters covering the recent advances in the field of plastics, laminates and protective coatings. The book has been extensively revised. The chapters on alloy steels and light metals have been almost completely rewritten and the material on wood is nearly all new. Many interesting charts are presented which have been adapted from current magazine articles.

One chapter discusses the industrial uses of water, soap and other detergents which all too often are neglected in similar studies. In fact, the enormous scope of Professor White's subject has not diminished his presentation of detail to any unwarranted extent. The volume is copiously illustrated, and at the end of every chapter there is a bibliography useful to anyone wishing further information on the various subjects presented.

Business, Legal, and Ethical Phases of Engineering

D. T. CANFIELD *and* J. H. BOWMAN, *Professors of Electrical Engineering, Purdue University. 358 pages, 6 x 9 in. Published by McGraw-Hill Publishing Co., 330 W. 42nd St., New York 18, N. Y. $4.50.*

A revision and combination of two well-known volumes: "Business Administration for Engineers" and "Legal and Ethical Phases of Engineering" by Professors Harding and Canfield.

The present volume is intended to acquaint engineering students with business, legal, and ethical situations that they are likely to encounter in practice. The book is based on the sound principle that an engineering training is of little value if it is not correlated with business and business men.

In this volume, the material retained has been generalized as far as possible, and illustrative material, examples, and

ARC WELDING CUTS COST 43%
...builds a stronger product

By A. D. NEAL,
Works Manager
B. F. Avery & Co.
Louisville, Kentucky

To avoid structural failures caused by striking hidden stumps or stones has been a major problem in the development of farm tractors and implements. By converting to welded design on key parts like axles and wheels, manufacturing has been simplified and field breakdowns virtually eliminated.

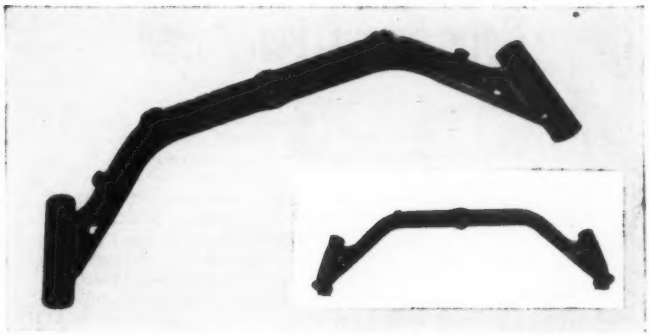


Fig. 1. *Weight reduced 30% . . . cost cut 43%.* Present design, all welded steel front axle. Has pressed steel channel frame and steel spindle housings. Inset shows former construction of cast steel.

IMPROVES DURABILITY

Experience shows that the welded designs have greater strength as well as exceptional resilience to severe mechanical shocks. Building the component parts from fabricated steel also eliminates the chance for any difficulties through inconsistencies in cast metals. Thus, with welded design, greater product dependability is achieved to meet unknown and abnormal operational needs.

Fig. 2. *Stronger and more durable* all welded steel front wheel for farm tractor now used.

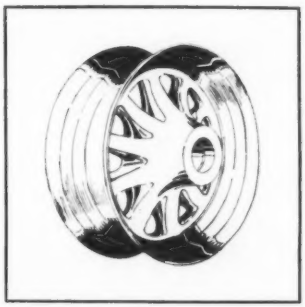


Fig. 3. *Former construction* had cast steel hub welded to rolled steel rim.

SIMPLIFIES MANUFACTURE

Substantial savings in manufacturing costs result in fabricating our tractor and implement parts with arc welding. Less material is required since components are stamped from steel plate or machined from bar stock with high speed equipment. Arc welding is done on simple, quick operating swing-type fixtures permitting fast downhand welding. On most jobs, no further machining is required after welding.

Fig. 4. *Cost cut 62% . . . weight down 69%.* Weld-fabricating a front tractor wheel. Component parts shown on table are located in simple fixture for welding.

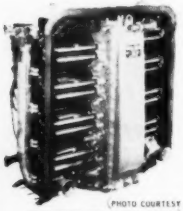
The above is published by **THE LINCOLN ELECTRIC COMPANY** *in the interests of progress.*
Machine Design Studies available to engineers and designers. Write The Lincoln Electric Company, Dept. 32, Cleveland 1, Ohio.

DC SILICONES

Silicone News

More Power Per Pound†

Call it plain laziness or call it "divine discontent," some potent force has driven us to seek more concentrated motive power ever since man started to move on wheels. But each increase in horsepower per pound has increased operating temperatures and created a need for more heat resistant materials. Dow Corning Silicones help to supply that need in such major developments as the new air-cooled gasoline engine by Continental Motors Corporation of Detroit.



(PHOTO COURTESY CONTINENTAL MOTORS CORPORATION)

Horsepower per pound in Continental's new line of air-cooled gasoline engines is increased as much as 100% in engines below 250 hp . . . more than 300% (down from 2400 to 777 lbs.) in the horizontally opposed 8 cylinder 250 hp engine shown at left. In this type of engine, Silastic gaskets are essential parts of the standard push-rod and tube assembly.*

Among the many problems solved by Continental engineers in designing this compact power plant, was the leakage of oil around the push-rod tube assembly. Hot oil and operating temperatures up to 500° F. severely limited the life of conventional gasketing materials. Continental engineers, however, knew about Silastic, the rubber-like Silicone by Dow Corning, and they asked for samples and technical assistance.

Silastic solved this problem because it is more heat-stable and more resistant to hot oils and to permanent deformation at temperatures above 200° F. than any other resilient material. Use of engines in sub-zero weather is not restricted by these gaskets of Silastic 161 because they are serviceable from —90° to 500° F. For more information about Silastic, ask for data sheet No. F-5H.

†See Silicone News, Dec. 1947, for story on 50% reduction in size and weight of electric motors made possible by Dow Corning Silicone Insulation.

*TRADE MARK REGISTERED U. S. PAT. OFF.

DOW CORNING CORPORATION • MIDLAND, MICHIGAN

Atlanta • Chicago • Cleveland • Dallas • New York • Los Angeles
In Canada: Fiberglas Canada, Ltd., Toronto
England: Albright and Wilson, Ltd., London

Dow Corning
FIRST IN SILICONES

problems have been added in the fields of chemical, civil, and mechanical engineering, as well as in electrical fields.

Divided into four main parts, the subjects covered are: Business economy, cost determination, business law, and engineering procedures. The appendix contains two chapters that are of especial interest to all engineers. One is a reprint of "The Unwritten Laws of Engineering" by W. J. King, which first appeared in *Mechanical Engineering*, the other is a reprint of "The Second Mile" by W. E. Wickenden, originally published in *Electrical Engineering*. Both are classics in their field.

Principles of Mathematical Physics

WILLIAM V. HOUSTON, *President, Rice Institute of Technology.* 363 *pages,* 6 x 9 *in. Published by The McGraw-Hill Book Co.,* 330 *W. 42nd St., New York* 18, *N. Y.* $5.

The first edition of this book was written as a text for a course designed to give the student some competence in the techniques of classical mathematical physics. This second edition has been amplified to serve this end better without any wide deviation from the fundamental method of approach. Chapters on mathematical methods alternate with chapters in which the methods are applied to physical problems.

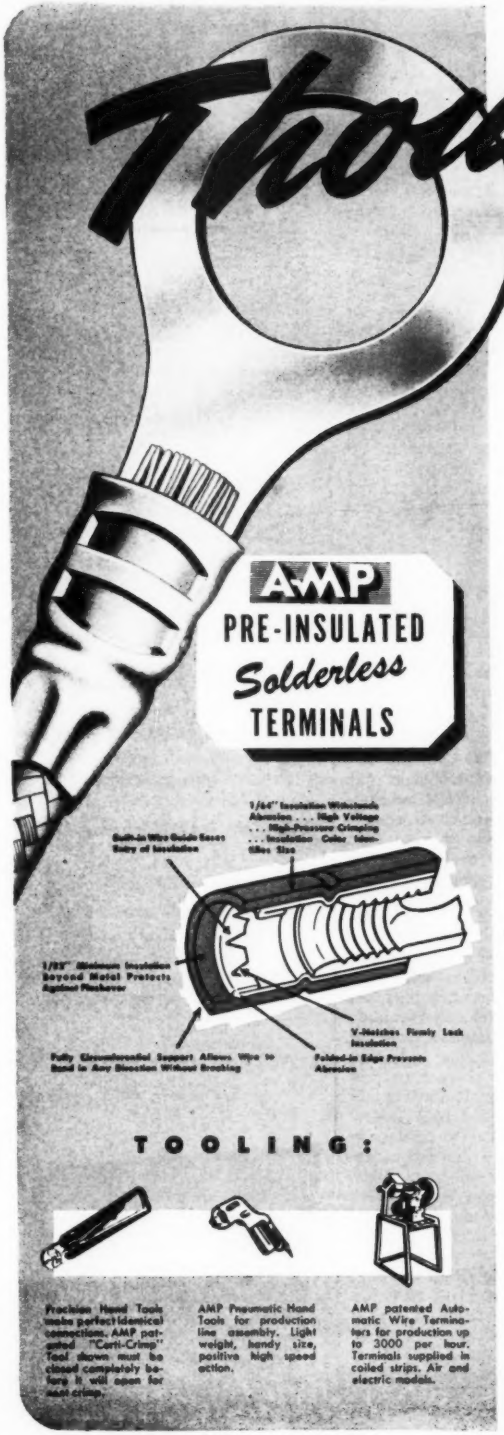
The amplification consists largely of the inclusion of numerous illustrative examples, addition of about forty drawings to clarify the text, and some minor rearrangements to provide a more coherent order of presentation. The chapters on electricity and magnetism have been expanded and revised.

Included in the chapter headings are: The mechanics of particles, linear equations of order higher than the first, mechanics of vibrating particles, calculus of variations, Hamilton's principle, theory of vibrating systems, vector analysis, dynamics of rigid bodies, thermodynamics, statistical mechanics, electrostatics, magnetostatics and the interaction of steady currents, the electromagnetic field, and the restricted theory of relativity.

Theory of Equations

J. V. USPENSKY, *Late Professor of Mathematics, Stanford University.* 353 *pages,* 6 x 9 *in. Published by McGraw-Hill Book Co.,* 330 *W. 42nd St., New York* 18, *N. Y.* $4.50.

A fully developed treatment of the theory of equations that is sufficiently elementary in character to permit study without the help of an instructor. All



Thousands OF PRODUCTION LINE RECORDS PROVE CONCLUSIVELY

THAT the cost of installing separate insulation tubing is approximately equal to the cost of installing a solderless terminal.

and **THAT** AMP patented Pre-Insulated Solderless Terminals reduce the installed cost of wire termination *because*

ONE CRIMPING OPERATION PRODUCES A PERFECT INSULATED CONNECTION. (The insulation is permanently bonded to the pure copper terminal barrel, and when crimped with AMP tool, forms a high quality permanently insulated connection.)

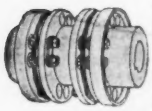
Available for wire sizes 22 to 10 inclusive in a wide variety of tongue shapes and stud hole sizes, AMP patented Pre-Insulated Terminals are eliminating costly and unnecessary installation methods. Samples will be sent upon request together with Catalog Section 10.

AIRCRAFT-MARINE PRODUCTS Inc.
1323 North 4th Street, Harrisburg, Pa.
Sole Canadian Representative:
F. Manley & Sons, Ltd., Toronto, Ont., Canada

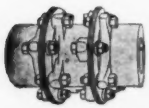
PRECISION ENGINEERING AMP APPLIED TO THE END OF A WIRE

THOMAS Flexible ALL METAL COUPLINGS

Engineered to stand up on the toughest jobs, Thomas Flexible Couplings do not depend on springs, gears, rubber or grids to drive. All power is transmitted by direct pull.

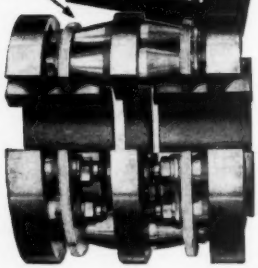


The standard line of Thomas Couplings meets practically all requirements. But if unusual conditions exist we are equipped to engineer and build special couplings.



BACKLASH FRICTION WEAR and CROSS-PULL are eliminated NO LUBRICATION REQUIRED!

PATENTED FLEXIBLE DISCS



THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT

Write for New Engineering Catalog

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

material is presented in complete detail, and no reference is made to anything beyond the scope of the book. The sections on computational methods have wide application in the solution of engineering problems.

In the chapter on separation of roots an original method is given for separating real roots. In the chapter on numerial computation of roots, Hoerner's method is presented in the original form, including the process of contraction. The error caused by contraction is thoroughly examined.

Determinants are introduced by their characteristics properties in the manner of Weierstrass. Some elementary notions concerning the algebra of matrices are also developed.

Because of their intrisic difficulty, certain topics are further developed in the appendixes; these include: The fundamental theorem of algebra, the theorem of Vincent, equations whose roots have negative real parts, iterative solution of the frequency equation, and Graeffe's method.

Mechanical Drawing

THOMAS E. FRENCH *and* CARL L. SVENSEN. *Fifth Edition, revised.* 6¾ x 9¼ *in., 437 pages. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York* 18, *N. Y.* $2.80.

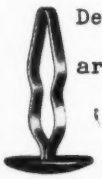
This edition, like the previous ones, represents the progress and improvements that have resulted from the experience of the teachers of mechanical drawing in large and small schools.

Changes and additions have been made to bring about conformity with modern industrial practice and with the high standards of modern drawing courses. The text has been rewritten, most of the illustrations have been improved and a large number of new illustrations and problems have been incorporated. The first nine chapters deal with specific subjects including fastenings, pictorial drawing, cams and gears, graphical solutions and sheet metal drafting. New chapters on production drawing, aircraft drawing and welding drawing have been added.

Actually, the chapter on production drawing amounts to a short art course in perspective representation. Illustrations include methods of rendering various materials and shading effects, assembly breakdown drawings and an example of a space drawing. In the section devoted to aircraft drafting, ways of depicting standard parts are included, as well as a section on lofting. The last chapter is devoted to nearly 600 different problems all of which are related to preceding chapters. Tables and teaching-aid suggestions are placed together in the index.

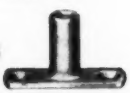
If you're looking for Special Fasteners...

in quantities suitable to volume production--Call upon United-Carr. Our Design Engineers are available to work directly with yours--



to show you how to

★ CUT COSTS



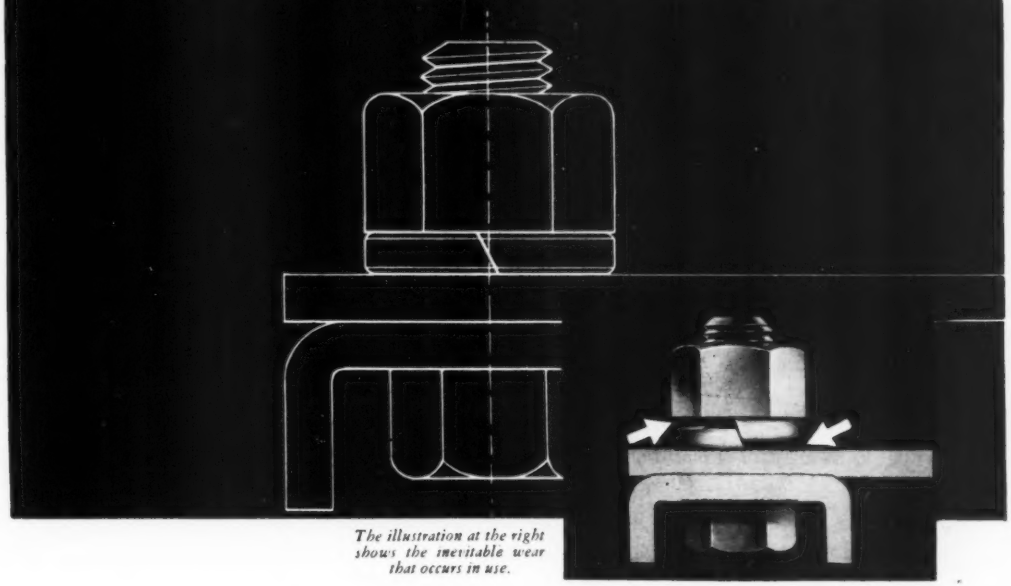
★ SPEED PRODUCTION

★ TURN OUT FINER FINISHED PRODUCTS

UNITED-CARR FASTENER Corp.
CAMBRIDGE 42, MASSACHUSETTS

MAKERS OF DOT FASTENERS

To Draftsmen, Engineers and Designers



The illustration at the right shows the inevitable wear that occurs in use.

Fundamentals are important, this is fundamental.

Many devices can lock a nut on a bolt so the nut **cannot** turn. But that alone is not sufficient.

Many constructions – so bolted – will loosen because of bolt stretch, and the frictional wear of metal on metal, burrs, flares, and the pulverizing of paint, scale and rust.

Since the advent of the castellated nut, research has found that looseness is usually caused by ductility, and wear at every contact point of metal surfaces.

From an engineering point of view, nut **locking** devices – although they may keep the nut from turning – do not and cannot give the necessary spring reaction that keeps bolted assemblies tight. **Vibration** and **stress loosen everything** – they always have and always will.

You **must** use a spring which expands as wear occurs. Expanding **spring** power retards initial wear, then compensates for later wear, and **holds parts tight** for a **long period** of time. **A strong spring does it – nothing else can.**

So **with** or **without** a nut locking device specify spring washers on every bolted construction you design.

The **live spring** gives you safety, economy, and efficiency.

Kantlink spring washers are strong, nontangling, helical springs with wide and ample reactive power – (spring expansion).

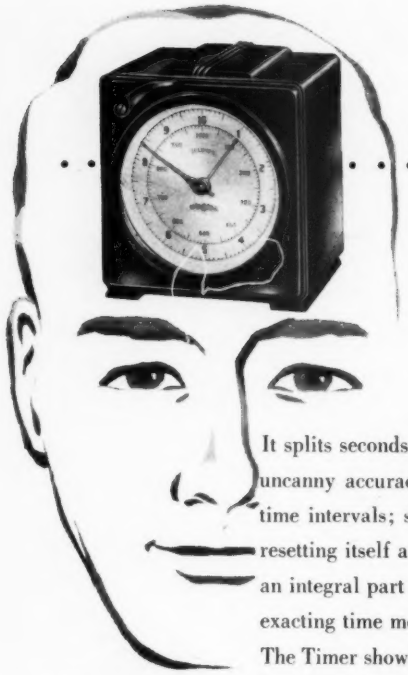
There is no substitute as economical. No fixed nut nor any other type or design of washer can possibly equal the great holding power of a **long range live spring** – a big helical spring such as Kantlink.

Write today for a descriptive folder.

Originators of KANTLINK the long range spring washer

THE NATIONAL LOCK WASHER COMPANY

Newark 5, New Jersey **Milwaukee 2, Wisconsin**



. . . this timer has an accurate memory

It splits seconds into thousandths with uncanny accuracy. It measures elapsed time intervals; starting, stopping and resetting itself automatically. It becomes an integral part of any operation where exacting time measurement is vital.

The Timer shown here is only one of a big family made by *Standard* that's indispensable for a wide variety of industrial uses. Standard Timers are made in models that measure time from .001 seconds to 1000 hours . . . with accuracies as low as .0002 seconds. You'll find, listed in Bulletin 153, a *Standard* Precision Timer suited to any time-measuring requirement you may have. Write for it today. T-2

Model S-1 STANDARD PRECISION TIMER. Speed 1 RPS. Totalizes 60 seconds; accuracy .01 seconds. Manual reset by lever on front of moulded bakelite case. 115 volt AC. Information on prices and optional equipment sent on request.

STANDARD
FOUNDED 1884

The STANDARD ELECTRIC TIME CO.
95 LOGAN STREET
SPRINGFIELD, MASSACHUSETTS

MAIL THIS COUPON TODAY!

Please send me Bulletin 153 which gives more information about *Standard* Timers.

Name .....
Title .....
Company .....
Address .....

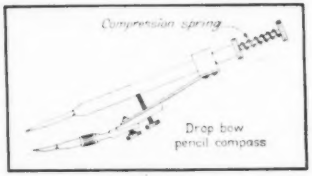
OUR READERS SAY

A Sketch in Time . . .

To the Editor:

Below is a sketch of a time-saving device which may be of interest to your readers.

When using the standard pencil drop compass, it is necessary to spin the compass several times to produce a heavy line. Even then it is difficult to



exert a uniform pressure on the pencil point while spinning the compass.

I have found that this annoyance can be overcome by installing a small spring on the compass which, in effect, spring loads the compass lead. Now a heavy line can be produced with only one revolution of the compass arm.

The spring from a pneumatic tire valve works in this application for most compass sizes.

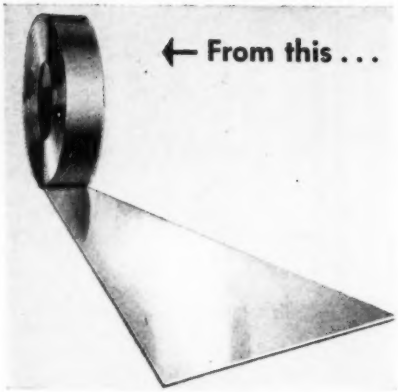
—E. L. HEMENWAY
Ridgefield, N. J.

Author's Rebuttal

To the Editor:

I have read Mr. Tatarinov's letter, published in the November issue of PRODUCT ENGINEERING, commenting upon my article entitled "Hydraulic Shock Absorber Orifice Designs and Equations."

Mr. Taratinov claims the formula for the Type 1 orifice to be confusing in that the ratio $\log_e v_o/O$ equals infinity. In the derivation v is shown never to reach zero. The physical explanation is that the only way to reach an end velocity of zero is to have an end orifice area equal to zero, a fact which is impossible in the constant area type of orifice. What is done, as the article explains, is to reduce the end velocity to a negligible magnitude so that its effect will be the same as if it were zero. Mr. Tatarinov, however, proceeds to make approximations of the velocity variation with respect to stroke and then solves for the orifice



Hunter Manufacturing Corporation roll forms sections of window frame . . . uses Kaiser Aluminum for the job because of its consistent high quality and workability.

Mass produced from coiled sheet in *ONE CONTINUOUS OPERATION!*

HOW? Hunter Manufacturing Corporation, Bristol, Pennsylvania, *roll forms* this section of window frame from a Kaiser Aluminum alloy!

It's a typical example of low cost fabrication possible with the uniform high quality and workability of Kaiser Aluminum.

In this operation Kaiser Aluminum coiled sheet is run through a 20-stand roll forming mill. Despite the severe forming done by these 20 rolls in a progressive operation, the completed section is produced in straight lengths, free from cracks and other defects.

As the continuous formed piece emerges —*at the rate of 75 feet per minute*—a traveling shear cuts it to exact length for final assembly.

What does this mean to you?

In the manufacture of your product, perhaps some parts can be mass produced by roll forming with the proper alloy of Kaiser Aluminum. If so, chances are you can get these tangible, dollars-and-cents benefits: Lower unit cost—greater uniformity of finished parts—improved surface finish—simplified production scheduling and planning.

And—due to Kaiser Aluminum's *lightness*—you'll get lower handling and shipping costs, reduced worker fatigue, lower labor costs!

But most important, you'll get a better product with Kaiser Aluminum! A product that's strong and durable, that won't rust and that can't be matched for sales appeal.

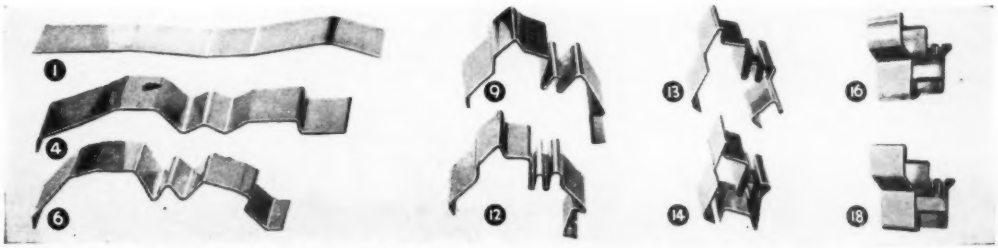
Whether your product is roll formed, spun, drawn, or fabricated by any other method, couldn't *you* lower costs by using the proper alloy of strong, versatile Kaiser Aluminum? Call in a Permanente engineer. He'll help you find the answer!

Permanente Metals

PRODUCERS OF

Kaiser Aluminum

SOLD BY PERMANENTE PRODUCTS COMPANY, KAISER BLDG., OAKLAND 12, CALIFORNIA: OFFICES IN MAJOR CITIES



These cross sections, taken from nine of the 20 stands of a roll forming mill, illustrate progressive stages of fabrication from Kaiser Aluminum coiled sheet to finished section. In one continuous operation an important part of a window frame is rapidly formed!

ELECTRIC WHEELS

Designed to do the Job

Wheels and Axles are our business, and our engineers are well qualified to recommend the most efficient assembly for your product.

Our factory is modern and tooled for low cost production. We have supplied manufacturers in many different industries for more than 50 years.

Standard or Special, ELECTRIC Spoke-type or Disc Wheels are built for most types of portable equipment.

Send us your specifications and we will submit our recommendations.

ELECTRIC WHEEL CO., 2910 Pine, Quincy, Ill.

MAKE YOUR PRODUCT FULLY NON-CORROSIVE!

STAINLESS STEEL SCREWS

IMMEDIATE DELIVERY

Machine, Self-tapping Socket, Set, Wood Screws. Also Nuts, Bolts, Washers, Rivets, Pins—all types and sizes—delivered immediately from America's largest stock.

PROMPT SHIPMENT ON SPECIALS

For Catalog No. 49 F, write today, on your letterhead.

STAINLESS STEEL FASTENERS

MANUFACTURERS SINCE 1929

ALLMETAL Screw Products Co., Inc.

33 GREENE STREET, NEW YORK 13, N. Y.

areas. My article gives the theoretically exact velocity variation and is independent of rough approximations.

—JOSEPH BROWN
Engineer, Naval Aircraft Factory

More than Questionnaires

To the Editor:

Permit me to add my voice to Mr. George Cawley's in condemning the present trend in motor car styling. I have often wondered, for instance, why someone did not do something about the bright work on the instrument board. The latter, together with the sharply receding windshield, makes it almost impossible to see anything because of reflections.

When *Collier's* magazine had a questionnaire on the subject of car styling I hastened to express my ideas, but from what I see on the roads today it will take more than questionnaires to get public opinion across to the designers. —P. M. SHERWIN
Mining Engineer

Taste Will Tell

To the Editor:

With reference to the editorial on car design in PRODUCT ENGINEERING, it is my belief that while car manufacturers are interested in any expression of opinion concerning their product, but they rely much more on customers' preference in the actual selection of a car than upon the results of surveys or polls.

Present day designs reflect manufacturers' interpretation of the purchasers' preference as indicated in the days when there were more cars than customers. While the automobiles on the market today may be similar in many respects to older models, there have been some significant changes which have provoked much criticism. However, when the customer is again free to buy the automobile he likes, there is little question but that car design will reflect the purchasers' current opinions. —S. W. SPARROW
Vice-President in Charge of Engineering, Studebaker Corporation

Creative Investment

To the Editor:

We want to thank you for allowing us to republish your editorial in our November number of Competition. The stand you take is well founded and illustrated; and because we think bank presidents as well as engineers will be interested in the belief that "a genuine product development program is not a design expense but a creative

44,000,000

PHOENIX
ARIZ.

TUBES

. . . IDENTICAL TO 0.001"

Modern mass production methods of the BB Pen Company of Hollywood, California, require ink cartridges held within strict dimensional tolerances: plus 0.0015" minus 0.0000" O.D.; plus 0.001" minus 0.000" I.D. Precision Tube Company has already supplied 44,261,000 brass tubes for these cartridges which, if laid end to end, would stretch from Philadelphia, Penna., to Phoenix, Ariz., and every one identical within the specified tolerances.

This Parade of Precision is possible only through highly specialized quality control—the same control used for the sizes, shapes, alloys, and finishes you specify. Contact Precision when you need non-ferrous tubing from 0.500" O.D. to 0.010" O.D. . . . wall thicknesses down to 0.0015".

When Precision Counts . . .
Count On Precision

Philadelphia, Pa.

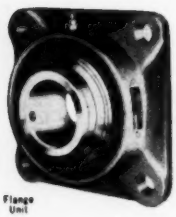
PRECISION TUBE CO.

3824-26 TERRACE STREET PHILADELPHIA 28, PA.

Important Features

Beyond the drawing board — *years from now* — the continued quiet and dependable operation of SealMaster units will amply justify their selection today. In every essential, SealMaster Ball Bearings contribute to smoother performance and low-cost maintenance. The five *important features* tell why:

1. **Permanently Sealed** — Dirt is excluded by the centrifugal flinger seals which also retain lubricant and prolong bearing life.
2. **Self-Aligning** — Shaft misalignment cannot distort the seals. Bearing unit, including seals, is independent of the housing.
3. **Pre-Lubricated** — Pre-lubricated at the factory, all SealMasters come ready for immediate use.
4. **No Housing Wear** — Patented locking pin prevents rotation of outer race in housing and positions bearing for re-lubrication.
5. **Quiet Operation** — Accomplished only by the SealMaster combination of deep-grooved, close-fitting, lapped ball races and balls and felt-lined seals.



Write for Catalog No. 845 which contains sizes, dimensions and complete engineering data.

BEARING DIVISION

STEPHEN S-A DAMSON

MFG. CO.

9 RIDGEWAY AVENUE, AURORA, ILLINOIS · LOS ANGELES, CALIF. · BELLEVILLE, ONT.

Factory Representatives and Dealers in All Principal Cities

investment", we are sending this November issue of our booklet to 2,000 bankers in addition to the usual 8,000 manufacturing executives.

—ROBERT T. MCNAMARA
Hill and Knowlton

Ed.—Additional copies of this booklet are available to readers who write to Hill and Knowlton, Republic Bldg., Cleveland 15, Ohio.

Indium-Lead Solder

To the Editor:

In the "Highlights" section of the November issue of PRODUCT ENGINEERING you ran a news item on indium-lead solder with a melting point of 600 F. We should like to know where we can obtain more information about this material.

—C. A. DOREMIRE
Sales Department, Dow Corning Corp.

Ed.—You can learn more about this solder from Soldering Specialties, 211 Kent Pl. Blvd., Summit, N. J.

Silver Signatures

To the Editor:

Could you tell us where we can find out about the ink containing silver oxide mixed with bismuth and glycerine which was mentioned in your November "Highlights" section of PRODUCT ENGINEERING?

—AUGUST R. KLEIN
Factory Manager, Rex Products Corp.

Ed.—Write to Silver News Letter, 1730 Eye St., N. W., Washington, D. C.

Welds or Rivets?

To the Editor:

In the paper, "Aspects of Large Passenger Liner Design," read by Messrs. Bates and Wanless at a meeting of the Society of N. A. & M. E. held on November 15, 1946, the authors discussed the following phenomenon which occurred aboard the German vessel, "Europa". After this ship had been in service about three years, serious cracks developed along the entire length of the sheer strake. Dock repair consisted of veeing out the cracks, welding and doubling the plate, but even these precautions did not prevent later cracking of the material. The authors of the article referred to above attempted to explain this happening by implying that the ship's hull was not designed for sufficient strength. These gentlemen did not mention a serious fire, which broke out on the vessel in 1926 when she was at the builder's yard. I had the

This little product went to market

This little product stayed home...

Know why?

There's more than one way to skin a cat—or build a product. A company that's using not-quite-perfect methods or materials puts its products under handicaps of price or performance. In some cases, it prevents the product from getting to market at all.

WHAT'S TO DO ABOUT IT?

The first thing to do is re-examine your own product. Many manufacturers could save money, save time, save floor space and labor by using die castings for one or more of their components—and have a better finished product in the bargain! Every part they produce by the old method is costing them money. Can that be *you?*

Why not go over your products now, with an eye to die casting development? We'll be glad to help you if we can.

Gerity-Michigan
CORPORATION
Adrian, Michigan

IRIDITE

on the zinc die cast

KitchenAid MIXER

Grips Paint-- Defies Underfilm Corrosion

Applied by a simple dip . . . without electric current . . . Iridite quickly forms a tough, corrosion-resistant coating on *any* zinc or cadmium surface. This Iridite film provides superior paint adherence by effectively sealing the metal from direct contact with the paint, yet grips the paint securely to block chipping, flaking, peeling.

Use the Iridite treatments, too, as a final finish for extreme corrosion resistance, or as a bright finish that keeps zinc or cadmium plated parts shining, clear of stains.

FREE to users of zinc or cadmium in any form—literature and samples of Iridite. Test it yourself! Or, if you prefer, send samples of your products for free processing.

ALLIED RESEARCH PRODUCTS, INC.

4004 EAST MONUMENT STREET

BALTIMORE 5, MD.

West Coast Licensee—
L. H. Butcher Co., Los Angeles 23, California

opportunity of examining a photograph of this fire which exhibited the method of extinguishment. Fire boats alongside poured a large quantity of water into the vessel. This cold water which came in contact with the hot plating had a quenching action that resulted in a loss of the material's ductility. Now, instead of the 25 percent elongation prescribed, only 10 percent might be reasonably expected. Naturally enough, after this fire, the skin of the ship was made up of parts having different mechanical properties than those which were anticipated by the designers. It is my belief that, because of this accident, sheer strake cracks later developed.

This example of what happened to the "Europa" demonstrates the importance of designing structures with materials of higher ductility values than would be necessary during conditions of ordinary loading. Accidental happenings can cause strength concentrations neglected in regular design calculations.

I remember the particular case of an 800 ton paddle wheel river tug which completed a 17,000 mile voyage through stormy seas. This vessel had not been designed to withstand heavy weather, but her hull, which was made up of riveted sections of soft ductile iron, did not show any failures though the ship vibrated violently under the pounding of twenty foot waves.

From these examples, I naturally form the opinion that stricter attention should be paid to structures after welding. Inevitably, physical properties of the base metal about the weld are altered, but annealing of these welded parts should help to restore lost ductility. I maintain that riveted joints in ships and other structures which undergo varying fatigue flexing will give more favorable elasticity and better stress distribution under overloads.

VICTOR TATARINOV
Consulting Engineer,
Pilsen, Czechoslovakia.

Ed.—Another paper, also presented to the Society of Naval Architects and Marine Engineers on November 7, 1944, was Leon Bibber's discussion on welded plate joints. Herein, he states, "the clue to the problem of cracking in ships does not lie in inadequate elongation of large welded structures, per se."

Aside from such accidents as Mr. Tatarinov sited with respect to the "Europa" fire, Mr. Bibber seems to feel that careless welding accounts for many of the failures usually attributed to the process itself. In the tests which the latter describes, he says that even the as-welded specimens, which contained residual stresses, "when tested at the relatively low temperature of 20 degrees F were capable of developing practically the full ultimate strength

Have you considered how this man can lower the cost of your springs?

THE gentleman pictured above represents Accurate's production-conscious engineers who are continually searching for ways to reduce your spring costs. Their record is an enviable one, too. Scores of manufacturers making all types of products have profited by Accurate's "know-how." We'd like to tell you about actual cases in which we have saved our customers substantial amounts. And, of course, we'd like to point out what we can do for you. Write, wire or phone, today.

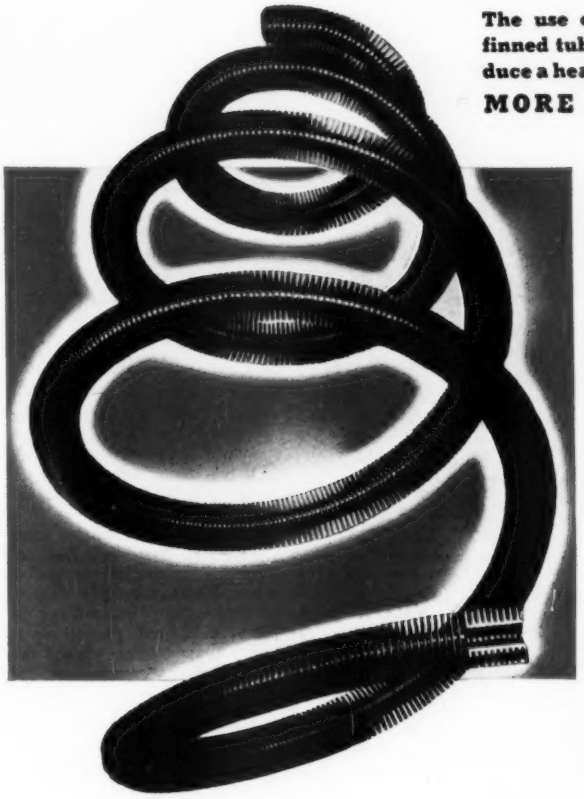
Accurate Springs

A dependable source of supply!

ACCURATE SPRING MFG. CO.
3815 W. Lake St. • Chicago 24, Ill.

Springs, Wire Forms, Stampings

And Wolverine Trufin can do as much for YOU

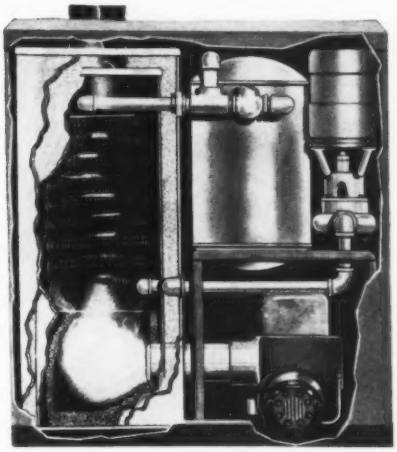


The use of Wolverine Trufin, the integral finned tube, enabled a manufacturer to produce a heating unit that offered his customers

MORE HEAT AT LESS COST

Just as it has brought advantages to this manufacturer—and thousands of others—in one way or another—by increasing efficiencies, bringing economies, improving design, etc.—this unique tube can bring benefits to YOU if you incorporate it as a component in your heat exchanger or other similar product.

In describing this Auburn Aqua-Finn Heater, the manufacturer points out that "copper was utilized in its construction to provide the utmost in heat with a minimum of fuel. Copper is five times as effective in conducting heat as iron, and seven times as effective as steel. With such efficiency, fuel consumption is cut 25% over other types of boilers . . . One inch of this finned tubing has the same heat exchange capacity as eight inches of the same size tubing without fins."



The cut-away diagram shows how a small coil of Trufin is used to effect this high efficiency. Because the fins are integral with the tube itself, Trufin will withstand vibration and extreme temperature changes. It can be bent easier than plain tube—and without special tools. It is available in a variety of diameters, alloys, fin heights and spacings.

WOLVERINE TUBE DIVISION
CALUMET AND HECLA CONSOLIDATED COPPER COMPANY
INCORPORATED
MANUFACTURERS OF SEAMLESS NON-FERROUS TUBING
1415 CENTRAL AVENUE • DETROIT 9, MICHIGAN

CRAFTSMANLIKE
UNIFORMITY
IN GEARS MADE TO YOUR SPECIFICATIONS
Gears for every industry are precision cut to your specifications. Racks . . . sprockets . . . spur . . . bevel . . . spiral . . . zerol . . . worms and worm gears. Send blue prints or samples for prompt estimates on any quantity.
E. B. SEWALL MANUFACTURING CO.
696 Glendale St. St. Paul 4, Minn.

The trained hand of Hassall offers you:
special nails • rivets • screws • made to your order
HASSALL cold-heading may solve your immediate special part problem... Special nails, rivets and threaded parts made in diameters from 1/32" to 3/8"—lengths up to 7"... Rivets 3/32" diameter and smaller a specialty... also small threaded blanks... Variety of metals, finishes and secondary operations... Economy, quality and quick delivery in large or small quantities... Your inquiries answered promptly... ASK FOR FREE CATALOG...3-color DECIMAL EQUIVALENTS WALL CHART free on request.
JOHN HASSALL, INC. 420 OAKLAND STREET BROOKLYN, N. Y.
Manufacturers of Cold-Headed Specialties—Established 1850
Hassall
ESTABLISHED 1850

and elongation obtained from a virgin base metal specimen, certainly far more strength and elongation than the joint could be called on to develop in a ship."

Since the "Europa" was built, and especially during the last world war, the United States and other countries have done a large amount of research on welding design of large structures, but even today this region of study can be looked upon as a relatively new field of engineering endeavor.

Letters Spell Progress

To the Editor:

In your July 1948 issue you carried an article called, "How to Stimulate Invention by Employees" by H. A. Toulmin. One paragraph of this story makes reference to the International Harvester Co. as follows:

> Although most large firms make active use of the "individual" suggestion system, many have abandoned it in favor of an organized invention plan. The International Harvester Co., for instance, discontinued the suggestion system because it felt that shop workers were seldom in a position to know what improvements were needed.

In reply to the statement made above, I received several calls from our Association members asking me to check with International Harvester as to the reason for discontinuing the suggestion plan; and particularly to ask the company why it released this statement which seems to imply that good ideas do not generally originate with shop men, but with trained specialists and engineers.

I wrote to Mr. John McCaffery, President of International Harvester, and received the following reply:

> We have been attempting to determine the origin of the statement to which you make reference, and can find no one in the General Office who has any knowledge of it.
>
> In reference to the statement quoted above, we wish to know upon what basis Toulmin made his statement.

— F. A. DENZ, *President National Association of Suggestion Systems*

Ed.—We were informed that Mr. Toulmin's assertion was originated by Harvester in 1928, and in another letter, Mr. Denz said that this explained his question. Of course, this very acknowledgment by Mr. Denz illustrates the progress management and labor have made in their relations. As a result of greater insight and certain suggestion system promotion, management is now more cognizant than ever of labor's suggestions concerning development and production of products.

Difficult? SURE! but

Sharon Stainless Steel takes this exceptional 2¾" depth in a single draw. It becomes even more remarkable when the three 1/16" radius corners—the unique taper and smooth conformation of the piece are considered.

Realizing the job called for the best material, the Dickey-Grabler Company, Cleveland, Ohio manufacturers, specified Sharon Stainless Steel 100 percent.

Sharon—a great name in steel—an even greater name in Stainless.

SHARON STEEL CORPORATION

Sharon, Pennsylvania

PRODUCERS OF SHARON STEEL CORPORATION AND SUBSIDIARIES: THE NILES ROLLING MILL COMPANY, NILES, OHIO; DETROIT TUBE AND STEEL COMPANY, DETROIT, MICHIGAN; SHARON STEEL COMPANY, WARREN, OHIO; SHARONITE PRODUCTS COMPANY, DETROIT, MICHIGAN, AND FARRELL, PENNA.; CARPENTERTOWN COAL & COKE CO., MT. PLEASANT, PENNA.; FAIRMONT COKE WORKS, FAIRMONT, W. VA.; MORGANTOWN COKE WORKS, MORGANTOWN, W. VA. Hot and Cold Rolled Stainless Strip Steel—Alloy Strip Steels—High Carbon Strip Steel—Galvanite Special Coated Products—Cee-overage Hoop—Electrical Steel Sheets—Hot Rolled Annealed and Descaled Sheets—Galvanized Sheets—Enameling Grade Steel—Welded Tubing—Galvanized and Fairpassed Steel Strip—Steel Strapping, Tools and Accessories.

DISTRICT SALES OFFICES: Chicago, Ill., Cincinnati, O., Cleveland, O., Dayton, O., Detroit, Mich., Indianapolis, Ind., Milwaukee, Wis., New York, N. Y., Philadelphia, Penna., Rochester, N. Y., Los Angeles, Calif., San Francisco, Calif., St. Louis, Mo., Montreal, Que., Toronto, Ont.

Designers, engineers and manufacturers of equipment calling for automatic timing find Haydon experience and practical knowledge of great value in solving timing problems. Many reset or repeat cycle timing obstacles which seem complex can be solved by application of one of the above units without variation. Sufficient volume will warrant development of tailor-made devices. Custom-built Haydon units feature simple design and low cost standard components.

Write to Haydon at Torrington, leader in the field of electric timing devices. Send full details including cycle chart, duty requirement, space limitations, voltage, frequency and unusual operating conditions. Engineering catalog available on request.

WRITE 3114 ELM STREET, TORRINGTON, CONNECTICUT

HAYDON

MANUFACTURING COMPANY, INC.

TORRINGTON CONNECTICUT

HARNESS TIME TO YOUR PRODUCTS

SUBSIDIARY OF GENERAL TIME INSTRUMENTS CORPORATION

Tempilstiks°

the amazing Crayons that tell temperatures

A simple method of controlling temperatures in:

- **WELDING**
- **FLAME-CUTTING**
- **TEMPERING**
- **FORGING**
- **CASTING**
- **MOLDING**
- **DRAWING**
- **STRAIGHTENING**
- **HEAT-TREATING IN GENERAL**

Also available in pellet and liquid form

It's this simple: Select the Tempilstik° for the working temperature you want. Mark your workpiece with it. When the Tempilstik° mark melts, the specified temperature has been reached.

$2 each

gives up to 2000 readings

Available in these temperatures (° F)			
125	275	500	1100
138	288	550	1150
150	300	600	1200
163	313	650	1250
175	325	700	1300
188	338	750	1350
200	350	800	1400
213	363	850	1450
225	375	900	1500
238	388	950	1550
250	400	1000	1600
263	450	1050	

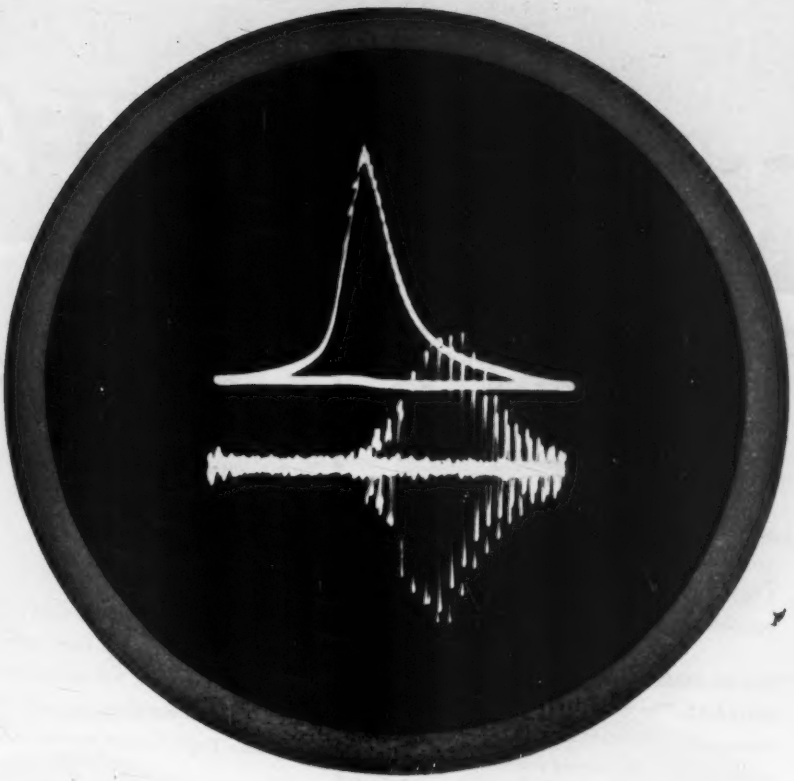
FREE *—Tempil° "Basic Guide to Ferrous Metallurgy"* — 16¼" by 21" plastic-laminated wall chart in color. Send for sample pellets, stating temperature of interest to you.

Tempil° corp.

132 WEST 22nd STREET

New York 11, N. Y.

We invite inquiries from reputable distributors interested in handling **Tempil°** *Products.*



This is a picture of "PING"

It's a picture that gives automotive engineers clear-cut facts on performance—a picture that suggests how photography with its ability to record, its accuracy and its speed, can play important roles in all modern business and industry.

No, this is not the "doodling" of a man on the telephone. Far from it. It's the photographic record of an oscilloscope trace that shows, and times, detonation in a "knocking" engine. It all happens in a few hundred-thousandths of a second—yet photography gets it clearly and accurately as nothing else can.

Oscillograph recording is but one of countless functional uses of photography in bettering products and improving manufacturing methods. High speed "stills" can freeze fast action at just the crucial moment—and the design or operation of a part can be adjusted to best advantage.

And high speed movies can expand a second of action into several minutes so that fast motion can be slowed down for observation—and products be made more dependable, more durable.

Such uses of photography—and many more—can help you improve your product, your tools, your production methods. For every day, functional photography is proving a valuable and important adjunct in more and more modern enterprises.

Eastman Kodak Company, Rochester 4, N. Y.

Functional Photography

. . . is advancing business and industrial technics

Kodak

REX TABLE TOP CHAIN

puts Plus Performance in your designs

If you're designing fillers, cappers, labelers, washers, pasteurizers or machines handling small parts or packages, Rex Table Top Conveyor Chain can help you design-in smooth, steady product movement. Here's why!

TABLE TOP ELIMINATES PILE-UPS AND SPILLAGE. The exclusive, hinged joint construction assures a constant carrying surface. There is no continuous gap across the width of the links as the chain flexes over sprockets to catch and trip containers. Accurately beveled edges allow smooth transfers . . . permit the chain to slide freely from under blocked containers. And Table Top will not tear paper cartons.

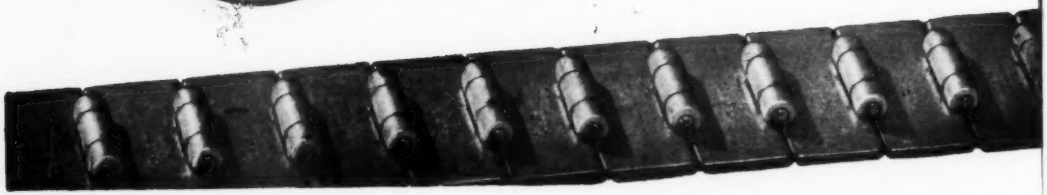
TABLE TOP HAS A SIMPLIFIED DESIGN. A one-piece platform link of case-hardened or stainless steel and a husky rivet is all there is to Table Top. There are no attachments or rivets to "loosen" or "wobble." Fewer parts mean greater steadiness, less chance for breakage, greater all-round efficiency.

TABLE TOP LASTS LONGER. The entire Table Top link absorbs the pulling load. Sprocket tooth bearing pressure is spread over the entire length of the joint not concentrated on a small area. This feature alone accounts for a great part of Table Top's longer service life.

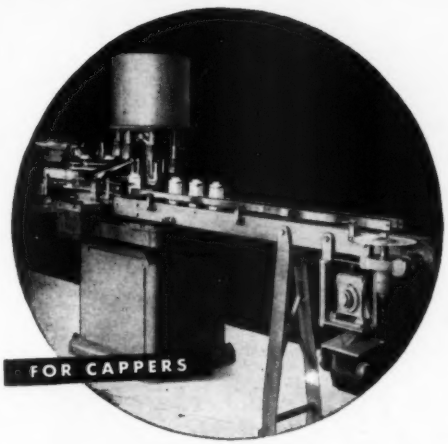
TABLE TOP STAYS CLEANER. There are no pockets on Table Top to catch and hold foreign matter. It's easy to clean . . . easy to keep clean. When cleaning is necessary, a jet of water or steam does the job in a hurry.

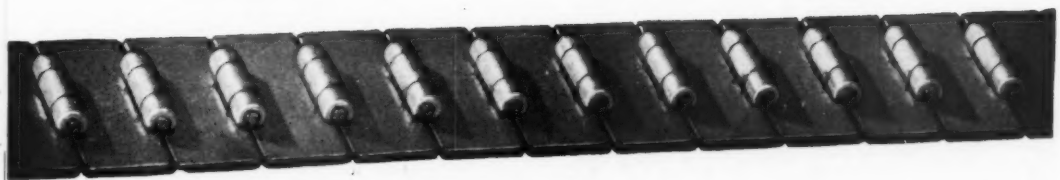
Many sizes of Table Top are available for immediate delivery. For all the facts, send for your copy of Bulletin No. 47-15. Chain Belt Company, 1715 West Bruce Street, Milwaukee 4, Wisconsin.

CHAIN BELT REX COMPANY — DRIVE AND CONVEYOR CHAINS



AS A TABLE TOP..





Depend on Reliable for Expert PLATING of Springs

Reliable

Do you use springs which are plated to your specifications? The properties and behavior of the better known metals and alloys of which your springs are made can be effectively improved and controlled by use of the correct plating process. The subject of spring platings is one undergoing constant advancement and evolution, as new methods and treatments are perfected.

The highly specialized technique of proper plated finishes, without impairment of the basic material itself, is a problem to which we have devoted close attention. We can give expert service on your plating needs. Also, our engineering department has prepared a short treatise on some phases of spring plating, mentioned below, which it will be worth your while to study. Reliable makes fine quality springs, wire forms and spring stampings for all purposes.

Ask for your copy of "Selecting Protective Finishes for Springs"

THE RELIABLE SPRING & WIRE FORMS CO.

3167 Fulton Rd. Cleveland 9, Ohio

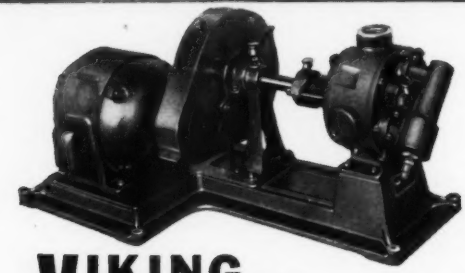
Representatives in Principal Cities

YOU CAN RELY ON

Reliable Springs

ROUND AND FLAT WIRE SPRINGS · CLIPS · HOOKS · BENDS · LIGHT STAMPINGS

MORE OF THE THINGS YOU WANT in a ROTARY PUMP



VIKING...

Gives You These Features:

1. Self priming—Steady and even discharge.
2. Proved simplicity—Only 2 moving parts . . . a "gear within a gear".
3. Slow speed—Long, dependable service.
4. Built to handle the liquid being pumped —No compromise construction.
5. Complete control of manufacture—From factory-owned and operated foundries to final assembly.

Send for bulletin 475X today—it will be sent promptly.

See Our Catalog in SWEET'S

Viking PUMP COMPANY Cedar Falls, Iowa

SEE WATSON-FLAGG

FOR GEARS—

QUALITY GEARS

WHERE END PERFORMANCE

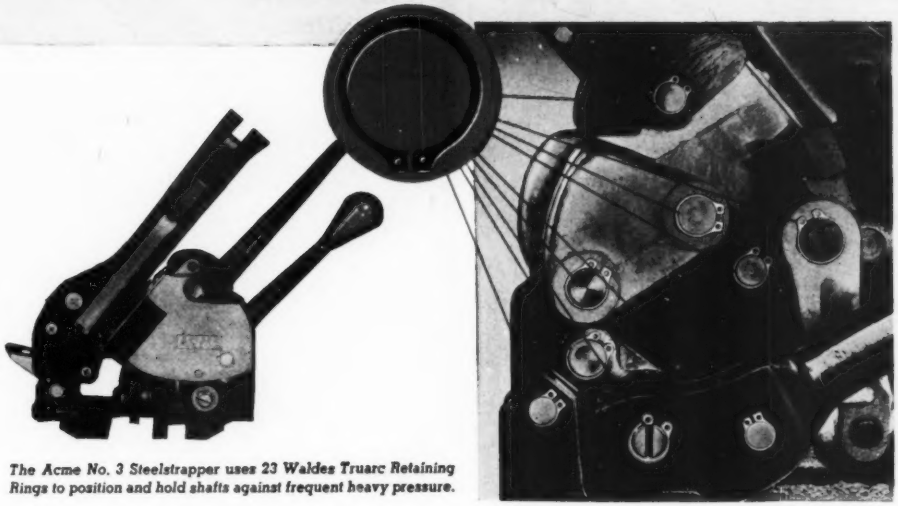
DEPENDS ON GEARMAKERS' SKILL

AGMA

WATSON-FLAGG MACHINE COMPANY, Inc.

Paterson, New Jersey

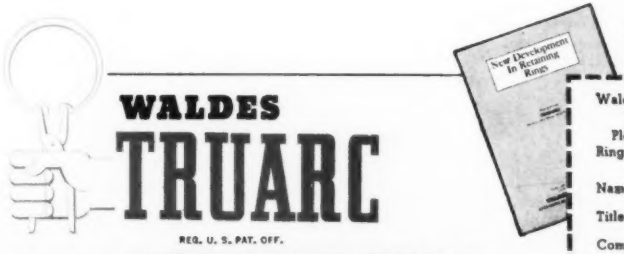
23 Truarc rings permit changeover to centerless grinding savings



The Acme No. 3 Steelstrapper uses 23 Waldes Truarc Retaining Rings to position and hold shafts against frequent heavy pressure.

"The use of Truarc Retaining Rings permits centerless grinding of pins instead of plunge-grinding. This eliminates the problem of taper and reduces the required tensional tolerances of these parts," reports Acme Steel Company of Chicago. "Furthermore, use of Truarc rings gives the Steelstrapper smoother lines by eliminating unsightly projections. This results in a more streamlined housing, a definite sales advantage."

Making repairs is much easier too, because Truarc simplifies assembly and disassembly. Truarc rings are precision engineered, may be used over and over again, remain always circular to give a never-failing grip. Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins—there's a Truarc ring that does a better job of holding parts together. Truarc cuts costs, adds sales advantages. Waldes Truarc engineers will be glad to show how Truarc can help you. Send us your problem.



● *Send for new Truarc booklet, "New Development In Retaining Rings"*

Waldes Kohinoor, Inc., 47-10 Austel Place PN-2
Long Island City 1, N. Y.

Please send booklet, "New Development In Retaining Rings" to:

Name_____

Title_____

Company_____

Business Address_____

City_____ Zone_____ State_____

WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY U. S. PATS. 2,302,948; 2,408,454; 2,416,852 AND OTHER PATS. PEND.

"This National Vulcanized Fibre Part solved our problem — assured us a product which performed perfectly."

*Required:
A material light in weight, resistant to wear, with good dielectric strength, ready machinability. National Vulcanized Fibre with all these qualities, plus—was the perfect answer.

In your development of efficient, economical products, it pays to investigate

NATIONAL VULCANIZED FIBRE

A tough, horn-like material with high dielectric and mechanical strength. Excellent machinability and forming qualities, great resistance to wear and abrasion, long life, light weight. Sheets, Rods, Tubes, Special Shapes.

PHENOLITE Laminated PLASTIC

About one-half the weight of aluminum, possesses an unusual combination of properties—a good electrical insulator, great mechanical strength, high resistance to moisture; ready machinability. Sheets, Rods, Tubes, Special Shapes.

PEERLESS INSULATION

The *first* fish paper developed for electrical insulation. Strong, smooth, flexible, with excellent forming qualities. High dielectric strength. Sheets, Rolls, Coils.

To help you solve your specific development problem—National Research and Engineering Service available without obligation.

NATIONAL VULCANIZED FIBRE CO.
WILMINGTON DELAWARE
Offices in Principal Cities
Since 1873

For heating water, paraffin, oils, chemicals, etc.

VULCAN ELECTRIC IMMERSION HEATING UNITS

Various types of Bolt-on flanges and threaded bushings available

Single and three heat with correct metal casings.

Complete with gaskets, terminal cover, etc.

A new VULCAN Electric Immersion Heater is especially designed for melting fats, greases and similar compounds.

VULCAN ELECTRIC COMPANY
DANVERS 18, MASS.

Makers of Electric Soldering Tools, Solder Pots and a wide variety of Heating Elements for assembly into manufacturers own products and of Heating Specialties that use electricity.

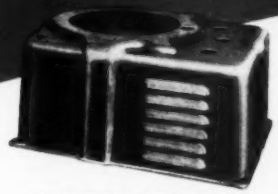
HELPFUL GUIDE FOR DESIGN ENGINEERS

Free Bulletin Shows How to Build TUTHILL Stripped PUMPS Into Your Machinery

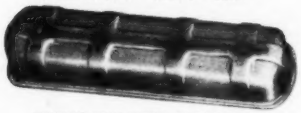
Where it is important to save space, material and labor, Tuthill provides special stripped model pumps that can be built directly into the design of the machine. Illustrated bulletin describes two types of stripped pumps available: Type S, without mounting bracket; and Type SA, with pumping elements only. Ideal for lubrication, coolant, hydraulic and liquid transfer service. Capacities up to 200 g.p.m. Write for Tuthill Stripped Pump bulletin.

TUTHILL PUMP COMPANY
939 E. 95th Street, Chicago 19, Ill. Phone REgent 4-7420

OIL PAN. 6" DEEP, 13" WIDE, 38" LONG.



BASE STAMPING FOR VERTICAL WELDER. 10-3/4" DEEP, 17" WIDE, 21" LONG.



CYLINDER HEAD COVER. 19-1/8" LONG, 5-11/32" WIDE, 3-1/2" DEEP.

CONSOL COVER FOR CREAM SEPARATOR. 6" DEEP, 11" WIDE, 17-1/4" LONG.

design engineering makes it right

OFTEN, design makes the difference in deep drawn steel stampings. Transue parts and die designers have an enviable reputation—held through years of broad, varied experience with complex stampings—for finding "the better way to make it." Something like that could come out of a conference between your engineers and ours. It costs nothing to try.

SALES OFFICES: NEW YORK, PHILADELPHIA, CHICAGO, DETROIT, INDIANAPOLIS, CLEVELAND

CYLINDER HEAD COVER. 27-5/8" LONG, 6-5/8" WIDE, 3" DEEP.

Designers and Makers of Deep Drawn Stampings

TRANSUE & WILLIAMS
ALLIANCE, OHIO

SEYMOUR BEST SELLERS WORTH READING ABOUT

Here are the quick facts on the popular, industry-specified Seymour alloys. To product designers and production engineers interested in reducing costs, improving quality, increasing product acceptance, complete details on these widely used alloys are available in the NEW catalogs on Seymour Nickel Silver and Seymour Phosphor Bronze. Write for yours *today*.

SEYMOUR ALLOY NO.	COMPOSITION %				
NICKEL SILVER	NICKEL	COPPER	ZINC	LEAD	TIN
● 18A1	18	65	17		
● 18A4	18	55	27		
● 18X1	18	62	19	1	
● 15A	15	64	21		
● 15X1	15	60	24	1	
● 15X2	15	60	23	2	
● 12A1	12	66	22		
● 12X1	12	60*	27	1	
● 12X2	12	60	26	2	
● 10A1	10	67	23		
● 10X1	10	60	29	1	
● 10X2	10	60	28	2	
● 5A1	5	68	27		
PHOSPHOR BRONZE					
● 950		95			5
● 494		94		1	5
● 928		92			8
● 910		90			10
● 444	88	4	4		4

USES

Seymour Nickel Silver is used for flatware, hollowware, name plates, surgical appliances, drafting instruments, camera parts, springs, electrical resistance units, optical goods, television parts, slide fasteners, costume jewelry, dental instruments, architectural trim, core bars, screws, keys, screw machine and milled products, orthopedic appliances, telephone assemblies, diaphragms, ornamentation and hundreds of other uses.

Seymour Phosphor Bronze is used for springs, diaphragms, fuse clips, lock washers, thermostatic controls, studs, microphone assemblies, electrical devices, nuts, bolts, gears, bushings, pump parts, pinions, plugs, etc.

OTHER SEYMOUR PRODUCTS

Seymour Nickel Anodes are produced under accurate pyrometric control. Special grain structure reduces sludge and loose nickel to a minimum. Seymour Anodes, in all shapes to meet rigid specifications, are also available in copper, brass, bronze and zinc.

Seymour Bright Nickel produces bright deposits over copper and brass and direct on steel without the usual coloring and buffing.

Seymour Phosphor Bronze Welding Rods are made specifically for high strength, ductile welds. Available in standard lengths, Grades A, C and D.

SEYMOUR SALES OFFICES

NEW YORK OFFICE
H. S. Samson, Mgr.
122 E. 42nd St., New York 17, N. Y.
Phone Murray Hill 3-5490

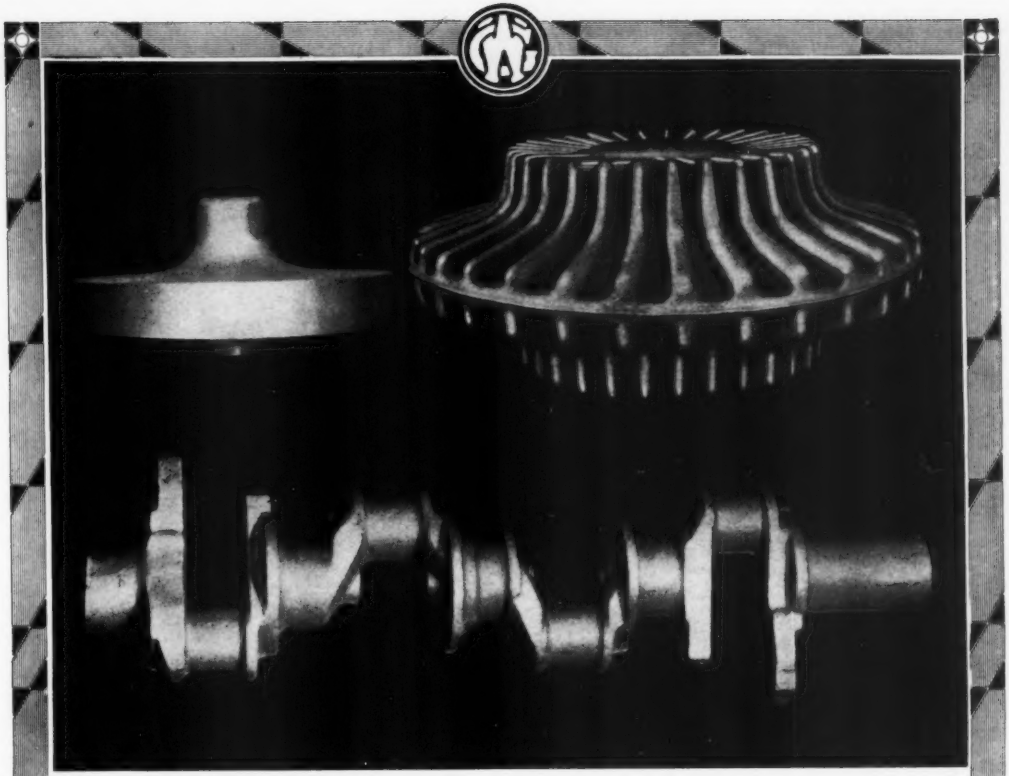
PROVIDENCE, R. I.
George M. Crawford
Box 418, Providence 1, R. I.
Phone Hopkins 6995

DISTRIBUTORS

THE COREY STEEL COMPANY
2800 South 61st Court, Cicero 50, Ill.
578 North Audubon Road, Indianapolis 19, Ind.
647 Bankers Building, Milwaukee 2, Wisc.
1113 Beale Street, South Bend 16, Indiana

WILLIAMS & COMPANY, INC.
3231 Fredonia Ave., Cincinnati 14, Ohio
3700 Perkins Avenue, Cleveland 14, Ohio
31 North Grant Ave., Columbus 15, Ohio
901-937 Pennsylvania Ave., Pittsburgh 12, Pa.
650 Woodruff Avenue, Toledo 2, Ohio

THE SEYMOUR MANUFACTURING COMPANY, SEYMOUR, CONNECTICUT



Wyman-Gordon—specialists in the vital forgings of the internal combustion engine since its inception—is today the largest producer of crankshafts for the automotive industry and of all types of forgings for the aircraft industry.

Be it crankshafts and other vital forgings for the piston type engines or turbine wheels and impellers for turbo jets—there is no substitute for Wyman-Gordon experience.

Standard of the Industry for More Than Sixty Years

WYMAN-GORDON

Forgings of Aluminum, Magnesium, Steel

WORCESTER, MASSACHUSETTS, U. S. A.

HARVEY, ILLINOIS - - - DETROIT, MICHIGAN

HOLO-KROME

Completely Cold Forged

FLAT HEAD

SOCKET CAP SCREWS

INTERNAL WRENCHING for Faster, Neater, Positive Assembly

Faster because H-K Hex Sockets and Keys fit accurately with no waste motion. Concentricity of head and body plus accurate threading eliminates binding.

Neater because internal wrenching prevents slip and skid marks of ordinary fastening methods.

Positive because they are completely cold forged from H-K Special Analysis heat treated Alloy Steel. Rolled to Class 3 Thread Fit. Individually hand inspected. H-K Flat Head Socket Cap Screws, as all Holo-Krome Socket Screws, give Guaranteed Unfailing Performance.

Holo-Krome Distributors are prepared to serve you from their warehouse stock

THE HOLO-KROME SCREW CORP. HARTFORD 10, CONN.

NEW CATALOGS AND BULLETINS

A Reader Service To Help Keep Your Library Up-to-Date

(1) **WIRE ROPE**—The Colorado Fuel and Iron Corp., Wickwire Spencers Steel Div., 500 Fifth Ave., New York 18, N. Y. Catalog, 127 pages. Contains well over a hundred charts, tables, drawings and photographs which show the designs, production methods, and applications of wire rope for use with heavy machinery.

(2) **ROLLER CHAIN**—Atlas Chain and Mfg. Co., Castor and Kensington Aves., Philadelphia 34, Pa. Catalog, 8 pages. Presents specifications and list prices for single and multiple chains ranging in size from No. 35 to No. 200, and discusses changes in the design and production of roller chain.

(3) **THERMOCOUPLES** — Wheelco Instruments Co., 847 W. Harrison St., Chicago 7, Ill. Bulletin T/C 7, 40 pages. Provides information on the selection of thermocouples and protecting tubes, methods of checking thermocouples and pyrometers, and installation data accompanied by charts and tables.

(4) **AIRCRAFT ACTUATORS**—Western Gear Works, Box 182, Lynwood, Cal. Catalog 4611, 36 pages. Includes data covering rotary, linear and cable-drum actuators with performance charts and specifications for over 15 actuator types.

(5) **INDUCTION HEATING**—The Ohio Crankshaft Co., Dept. D-12, Cleveland 1, Ohio. Catalog 25 Section A-D, 48 pages. Offers in four sections illustrated information on the principles of induction heating, results of induction hardening and heat treating, effects of forming and forging with induction heating, and consequences of induction annealing.

(6) **PHOSPHOR BRONZE**—The Phosphor Bronze Corp., 2300 Washington Ave., Philadelphia 46, Pa. Catalog, 12 pages. Contains separate descriptions of phosphor bronze sheet, wire rope, castings, bushings and ingots, together with tables of physical properties, chemical analyses and specifications plus data on spring design and machinability.

(7) **RHEOSTATS**—James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa. Bulletin 41-32, 11 pages. Describes the standard, screw-drive, double, graded, switchboard, metal caged and non-inductive rheostats along with performance tables and charts to aid in selection.

(8) **SYNCHRONOUS MOTORS**—General Electric Co., Apparatus Dept., Schenectady 5, N. Y. Leaflet, 4 pages. Contains ratings and construction details on Series 800, high speed synchronous motors.

(9) **FLEXIBLE TUBING**—Pennsylvania Flexible Metallic Tubing Co., 72nd St. & Powers Lane, Philadelphia 42, Pa. Bulletin, 6 pages. Illustrates and describes applications and construction of various types of flexible tubing.

(10) **SALT CORROSION**—The International Nickel Co., 67 Wall St., New York, N. Y. Booklet, 20 pages. Contains discussion of salt corrosion and the methods that have been adopted to lessen this phenomenon.

(11) **VALVES AND GAGES**—The Paul S. Huyette Co., Inc., 295 N. 43rd St., New York 17, N. Y. Leaflet, 4 pages. Contains illustrated descriptions of water gages; air, oil or water cylinders and valves.

(12) **DIE CASTING**—Los Angeles Die Casting Co., 149 Crocker St., Los Angeles 12, Cal. Bulletin, 6 pages. Presents die casting processes and shows how casting affects strength, possibilities of design and uniformity of finished parts.

(13) **CONTROL VALVE**—Cochrane Corp., 17th St. & Allegheny Ave., Philadelphia 32, Pa. Bulletin 4460, 8 pages. Describes the Hydromatic Single Control Valve for softeners and pressure filters.

(14) **FLOW METERS** — Schutte and Koerting Co., 12th and Thompson Sts., Philadelphia 22, Pa. Bulletin 14-RA, 4 pages. Shows pictures and describes uses of 23 different types of flow meters, and gives explanation of working principle.

(15) **PROTECTIVE COATINGS**—American Paint Co., Ambler, Pa. Folders, 6 pages each. A set of seven folders each of which treats one coating process. These include: Alodine, Deoxidine, Duridine, Granodizing, Lithoform, Rodine, and Thermoil-Granodine.

(16) **WELDING PROCESS**—Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y. Folder, 6 pages. Gives complete details and description of the new Aircomatic process which was introduced at the National Metal Exposition.

(17) **ELECTRIC MOTORS**—The Brown-Brookmeyer Co., Dayton 1, Ohio. Bulletin 5050, 6 pages. Illustrates and describes complete line of standard and special type motors, such as split phase, resilient mounted, squirrel cage, and right angle geared head motors.

(18) **SPEED MEASURING** — James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa. Bulletin 15-32, 24 pages. Explains operation of chronometric, centrifugal and resonant reed tachometers.

(19) **MINIATURE MOTORS**—Globe Industries, Inc., 115 Stanley Pl., Dayton 7, Ohio. Bulletin M-5, 11 pages. Gives dimensional drawings, performance curves, tables and descriptions of various types of small motors with such accessories as gear reduction units, blowers, and vibrators.

(20) **INERT GAS WELDING**—Fansteel Metallurgical Corp., North Chicago, Ill. Bulletin 102, 6 pages. Contains infor-

HOW TO ORDER — Two post cards are printed here. On each is room for you to request four pieces of literature. If you are requesting four pieces or less, please use only the bottom card. For five to eight pieces use both cards.

Write in circle number of item describing one catalog wanted →

Name.....

Company.....

Address.....

.....Title.....

PRODUCT ENGINEERING, New York. 2-49
Not good after April 1, 1949

Write in circle number of item describing one catalog wanted →

Name.....

Company.....

Address.....

.....Title.....

PRODUCT ENGINEERING, New York. 2-49
Not good after April 1, 1949

Write in circle number of item describing one catalog wanted →

Name.....

Company.....

Address.....

.....Title.....

PRODUCT ENGINEERING, New York. 2-49
Not good after April 1, 1949

Write in circle number of item describing one catalog wanted →

Name.....

Company.....

Address.....

.....Title.....

PRODUCT ENGINEERING, New York. 2-49
Not good after April 1, 1949

PLACE 3¢ STAMP HERE

PRODUCT ENGINEERING
330 West 42nd St.
New York 18, N. Y.

mation on the use of tungsten electrodes for use with helium, argon or atomic hydrogen arc welding.

(21) **WHEELS AND HUBS**—Kelsey-Hayes Wheel Co., French & Hecht Div., Davenport, Iowa. Catalog, 33 pages. Contains illustrations of various wheel types, size and part tables, together with cross-sections showing construction of disk, cast iron or steel spoke wheels.

(22) **V-BELTS**—B. F. Goodrich Co., Akron, Ohio. Bulletin 3170-1, 4 pages. Pictures and describes construction of Multi-V-Belts, and gives belt numbers, sizes and pitch lengths plus the solution of a typical belt design problem.

(23) **LOAD CENTER SUBSTATIONS**—Allis-Chalmers Mfg. Co., S. 70th St., Milwaukee, Wis. Bulletin 11B6385A, 15 pages. Besides a nomogram to select air circuit breaker for any load center substation, bulletin contains sizes and dimensions of load center transformers, vertical lift metal-clad switchgear and type L switchgear.

(24) **RECORDERS AND CONTROLLERS**—Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. Catalog ND44(1), 31 pages. Guide to complete line of Model S Micromax Recorders and Controllers. Presents 11 pages of tables on data for instruments which measure pressure, speed, voltage, frequency, load, humidity, smoke density, and conductivity.

(25) **POLYSTYRENE POWDER**—Rohm & Haas Co., Plastics Dept., Philadelphia, Pa. Bulletin, 13 pages. On Plexane M for injection molding, bulletin describes plastic's physical and mechanical properties plus suggestions for machining, such as surface speeds and tool angles.

(26) **CLUTCH FACINGS**—Raybestos-Manhattan, Inc., Equipment Sales Div., 670 Fisher Bldg., Detroit 2, Mich. Bulletin 300, 7 pages. Pictures 18 types and describes 25 clutch facings. Contains table of coefficients of friction, service conditions, size limits and tolerances.

(27) **BURNISHING ROLLERS**—Raynes Stellite Co., Kokomo, Ind. Leaflet, 4 pages. Shows methods of burnishing with various types of roller shapes, and gives recommended applications, dimensions, part numbers and prices of these rollers.

(28) **BRASS AND BRONZE EXTRUSIONS**—Titan Metal Mfg. Co., Bellefonte, Pa. Leaflet, 4 pages. Lists chemical composition and physical properties of nine alloys used for extrusion and illustrates many different forms in which these extrusions are available.

(29) **PLUG VALVES**—H. K. Porter Co., Inc., 7001 W. 44th Pl., Chicago 38, Ill. Shows cross-sectional picture with accompanying explanation of lubricated plug valve plus tables of sizes, weights, type of pressure gun lubricator, wrench sizes and locking device.

(30) **MOTORS**—Electric Boat Co., Electro Dynamic Div., Bayonne, N. J. Leaflet 3003, 4 pages. Gives illustrations to show construction and a graph to indicate torque load for 5 differently designed, totally inclosed motors ranging from 1 to 60 horsepower.

(31) **STARTERS AND CONTACTORS**—Arrow-Hart & Hegeman Electric Co., 103 Hawthorn St., Hartford 6, Conn., Folder, 2 pages. Information on application and installation of Size 0 and 1 type RA starters and contactors.

(32) **POLYMERIC RESIN**—American Cyanamid Co., Coating Resins Dept., 30 Rockefeller Plaza, New York 20, N. Y. Leaflet, 4 pages. Presents resin characteristics and film properties of Copolymer resin for air-dryed or baked industrial finishes.

(33) **LUBRICATED PLUG VALVES**—Homestead Valve Mfg. Co., Coraopolis, Pa. Folder, 4 pages. Shows cutaway drawing and describes working principle of plug valves with table to aid in size selection.

(34) **WELDING RODS**—Eutectic Welding Alloys Corp., 40 Worth St., New York 13, N. Y. Presents information on low temperature welding rods for cast iron, steel, nickel and monel, zinc die castings, aluminum, and magnesium.

(35) **INDUSTRIAL PACKINGS**—Crane Packing Co., 1800 Cuyler Ave., Chicago 13, Ill. Catalog, 15 pages. Gives illustrated descriptions of sheet, metallic, and fiber packings for such applications as gaskets, rods and valve stems, condenser tubes, and expansion joints.

(36) **ADHESIVES**—B. F. Goodrich Co., Akron, Ohio. Catalog 3160, 6 pages. Reports on cement classifications, service requirements, and humidity effects on various pure gums and compounded type adhesives.

(37) **METAL HOSE**—Chicago Metal Hose Corp., Wallock Manufacturing Div., Maywood, Ill. Bulletin CH-48, 4 pages. Shows applications and gives standard lengths and sizes for coolant hose.

(38) **GAS WELDING APPARATUS**—Victor Equipment Co., 3821 Santa Fe Ave., Los Angeles 11, Calif. Catalog 20S, 39 pages. Contains selection data and informative cutaway pictures for welding equipment parts.

(39) **MEEHANITE DESIGN DATA**—Meehanite Metal Corp., Pershing Square Bldg., New Rochelle, N. Y. Bulletin 27, 19 pages. Presents formulas and charts for computing maximum stresses in angles, ribbed plates and shear resistant webs containing cutouts.

(40) **TRIPPING SWITCH**—First Industrial Corp., Micro Switch Div., Freeport, Ill., Bulletin 51, 4 pages. Pictorially shows operation and installation of new electrical device for safe control of tripping mechanisms on manually operated equipment.

(41) **FATIGUE TESTING**—The Baldwin Locomotive Works, Philadelphia, 42, Pa. Bulletin 201, 8 pages. Shows need for testing designs and materials for fatigue, and emphasizes uncertainty of static load tests when dynamic service conditions occur.

(42) **ZINC DIE CASTINGS**—The New Jersey Zinc Co., 160 Front St., New York 7, N. Y. Booklet, 68 pages. Contains 168 photographs of zinc die castings in 10 major consuming fields and describes various castings.

(43) **SURFACE CONTROL**—Physicists Research Co., 321 S. Main St., Ann Arbor, Mich. Bulletin, 4 pages. Outlines the importance and applications of latest surface control methods on machined, ground and finished surfaces.

(44) **FIBROUS BRONZE**—American Non-Gran Bronze Co., Berwyn, Pa. Leaflet, 4 pages. Contains information on applications, physical characteristics and structure of this non-granular bronze along with table of bar sizes.

(45) **DISK RECORDERS**—Penn Industrial Instrument Corp., 1116 N. 17th St., Philadelphia 22, Pa. Bulletin 700, 16 pages. On construction, operation and selection of temperature and pressure recorders.

HOW TO ORDER—Two post cards are printed here. On each is room for you to request four pieces of literature. If you are requesting four pieces or less, please use only the bottom card. For five to eight pieces use both cards.

PLACE 2¢ STAMP HERE

PRODUCT ENGINEERING

330 West 42nd St.

New York 18, N. Y.

Write in circle number of item describing one catalog wanted →

Name.....

Company.....

Address.....

.....Title.....

PRODUCT ENGINEERING, New York. 2-49

Not good after April 1, 1949

Write in circle number of item describing one catalog wanted →

Name.....

Company.....

Address.....

.....Title.....

PRODUCT ENGINEERING, New York. 2-49

Not good after April 1, 1949

Write in circle number of item describing one catalog wanted →

Name.....

Company.....

Address.....

.....Title.....

PRODUCT ENGINEERING, New York. 2-49

Not good after April 1, 1949

Write in circle number of item describing one catalog wanted →

Name.....

Company.....

Address.....

.....Title.....

PRODUCT ENGINEERING, New York. 2-49

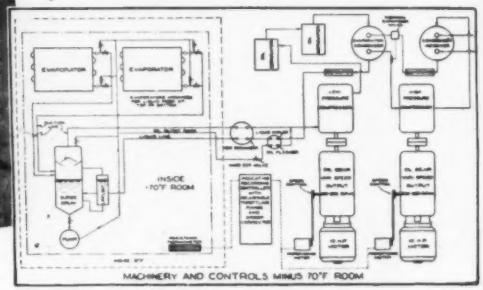
Not good after April 1, 1949

A STEADY 102° BELOW FREEZING

. . . CALLED FOR CONTINUOUSLY VARIABLE SPEEDS AND STABLE OUTPUT TORQUE

(Photo and Schematic from Refrigerating Engineering)

Two Oilgear Fluid Power Transmissions driving compressors for research laboratory's —70 degree testing room. (Other Oilgear Transmission drives compressor for 0 degree room.) Output speed of transmissions varies according to temperature differential upon resistance thermometers. Control of speed is entirely automatic. Manual control for starting is optional. Oilgear Fluid Power Drives and compressors operate continuously. (See schematic below).



MACHINERY AND CONTROLS MINUS 70°F ROOM

OILGEAR *Fluid Power* SOLVED THIS PROBLEM

The wide range of installations that demonstrate the reliability, scope and ease of control of Oilgear Fluid Power Drives and Transmissions grows daily. A case history from REFRIGERATING ENGINEERING, official journal of the American Society of Refrigerating Engineers, telling how a research laboratory chose Oilgear Transmissions and obtained continuous, dependable performance without delay, is another chapter in that story.

Demands for tests of materials at extreme temperatures called for equipment able to hold testing room temperatures stable at all times—usually at 70° F. below zero. It also had to refrigerate test materials as rapidly as possible. This meant a system of varying compressor speeds automatically—so as to compensate for variations in heat load.

Previous experience had shown that . . . the use of direct current motors, or variable speed drives of the belt-and-pulley type, under automatic control, was not entirely reliable and required considerable servicing.

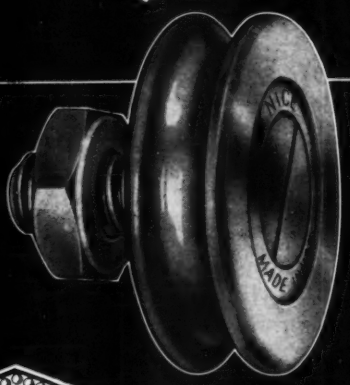
Then Oilgear Fluid Power Transmissions were adopted. These transmissions provide continuously and automatically variable output speed and maximum output torque at all operating speeds. Nearly two years' experience reveals that temperatures have been maintained within ±½° F. of the desired figure over long periods of time, that no attendant is required except for a few minutes' daily routine inspection, that the Oilgear drives are completely reliable.

Thus the evidence grows that if you are tired of machine or process drives and transmissions that don't stand up, if you want simpler, better, more productive and dependable drives, if you have problems not yet solved, it will pay you to contact Oilgear Fluid Power engineers. THE OILGEAR COMPANY, 1571 W. Pierce St., Milwaukee 4, Wis.

Oilgear Fluid Power

Have you given NICE a chance to Quote?

STANDARD and
SPECIAL BALL BEARINGS
Since 1902



WRITE FOR
CATALOG NO. 125

NICE

NICE BALL BEARING COMPANY
NICETOWN · PHILADELPHIA · PENNSYLVANIA

800 ohms/cmf

Temp. Coeff. of Resistance:
± 0.00002 max. from −50°c to +100°c

Karma

the improved electrical resistance alloy!

Higher Ohmage makes possible Smaller Resistors—Increased Savings

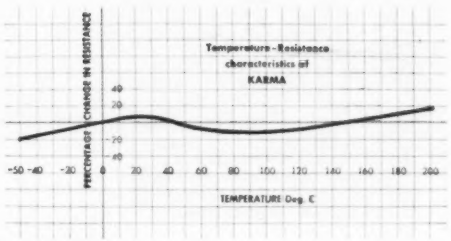
Compared with Manganin and Constantan (Advance*), the copper-base alloys widely used for high accuracy wire-wound resistors, the electrical resistivity of Karma* is exceptional — 800 ohms per circular mil foot, at 20°C, it is more than 2.7 times greater. Now you can wind even smaller precision resistors at still lower cost per ohm.

More Stable Resistance permits Wider Applications—at Wider Temperature Ranges

The comparably Low Temperature Coefficient of Resistance of Karma remains constant over a very much wider temperature range than that of Manganin or Constantan (Advance*). The "useful range" of Karma is more than 8 times that of Maganin and 4 times that of Constantan (Advance*). Karma, therefore, is especially adapted for service in precision resistors that are subjected to severe changes in temperature.

Low Thermal EMF Value against Copper assures Extreme Accuracy

In cases where error due to voltage generated by thermal EMF against copper must be confined to negligible proportions, Manganin has long been accepted as ideal for resistor windings. The thermal EMF value for Karma against copper is equal to that of Manganin itself!



High Resistance to Oxidation prolongs Electrical Properties

The superior surface oxidation resistance of Karma, essentially a nickel chromium alloy, enables it to retain its fine electrical properties longer than the copper-base alloys Manganin and Constantan (Advance*).

Higher Tensile Strength permits Faster Winding Speeds — saves Production Time

In addition to its outstanding electrical qualities, Karma affords physical advantages over the commonly accepted alloys. Its higher tensile strength permits faster winding speeds; its lower thermal expansion minimizes distortion and movement in windings.

In a word, this urgently needed Driver-Harris alloy offers *plus values all along the line*. Ask us about it. We shall be glad to supply you with complete data.

50TH YEAR · SPECIAL PURPOSE ALLOYS SINCE 1899 · D/H · TRADE MARK REG. U.S. PAT. OFF. · 1899 - 1949

KARMA is manufactured only by

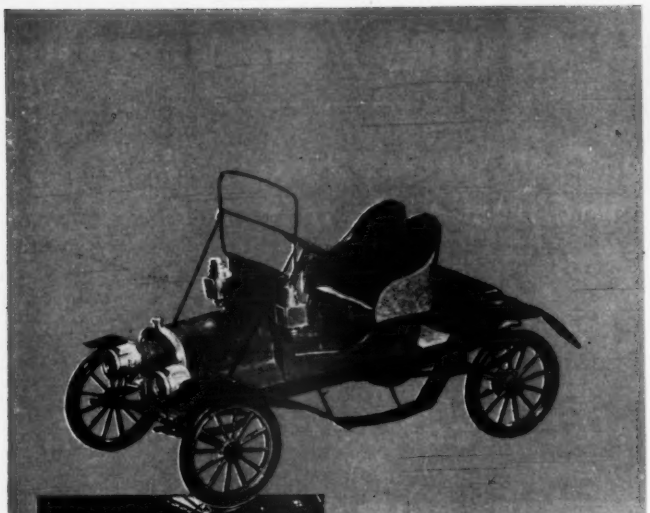
Driver-Harris Company

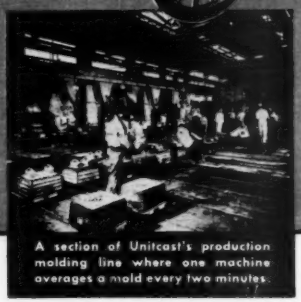
HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco, Seattle

Manufactured and sold in Canada by
The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

*T.M. Reg.U.S.Pat.Off. *Formerly D-H experimental alloy #331





A section of Unitcast's production molding line where one machine averages a mold every two minutes.

. . of Models and MOLDS

The skill and patience of craftsmen that execute miniatures often compares but never attains the degree of detail . . . comprehensive detail that is required of craftsmen who mold dependable steel castings.

For example, Unitcast's production molding system is based on coordination of details. Here, in the hub of the foundry, materials from sustaining departments meet prearranged schedules to initiate the form of fine steel Unitcastings.

It is difficult to visualize what comprehensive details are actually necessary to operate Unitcast's precision mass production! Briefly, advance planning must be thorough and, as jobs enter actual production, a daily re-check on schedules maintained. Continuous production of numerous types, shapes and sizes of Unitcastings requires that schedules be coordinated with supply lines and molding equipment capacities. Pattern equipment must be transposed properly and the entire battery of molding equipment must be kept operating efficiently.

Yet, it's all in the days work. With Unitcastings, like model making, painstaking time and patience have established long records of proven standards that assure Unitcast's customers the benefit of efficient casting proceedure. Take advantage of Unitcast's *proven* experience . . . for your next job specify Unitcastings!

Unitcast Corporation, Steel Casting Division, Toledo 9, O. *In Canada:* Canadian-Unitcast Steel, Ltd., Sherbrooke, Quebec.

PRODUCTS LAST ***LONGER*** BUILT WITH ***STRONGER*** UNITCASTINGS

UNITCAST *Corporation*

ELECTRIC STEEL CASTINGS

TO PRODUCT ENGINEERS SEEKING IMPROVED PRODUCT APPEARANCE *at reasonable cost* IN 1949

For the first time in many years, Stolper has plant capacity for a few additional accounts. With facilities expanded, and 41 years of experience producing quality custom-built sheet metal parts and assemblies for many of America's leading manufacturers, we are prepared to serve you well. If your requirements fit in with these expanded facilities, Stolper may help you win more 1949 business. Tell us your needs. We'll tell you just what we can do for you.

Send Blueprints, Specifications and Your Volume-Forecast . . . for Quotations

In complete confidence, Stolper Sheet metal engineers will analyze your requirements as you outline them. Our aim is to function as an integral part of your own organization . . . to give your parts and assemblies improved appearance, top quality, at reasonable cost. If you can use this sort of production cooperation, Stolper is ready!

STOLPER STEEL PRODUCTS CORP.

3258 W. Fond du Lac Ave. • Dept. PI
MILWAUKEE 10, WISCONSIN

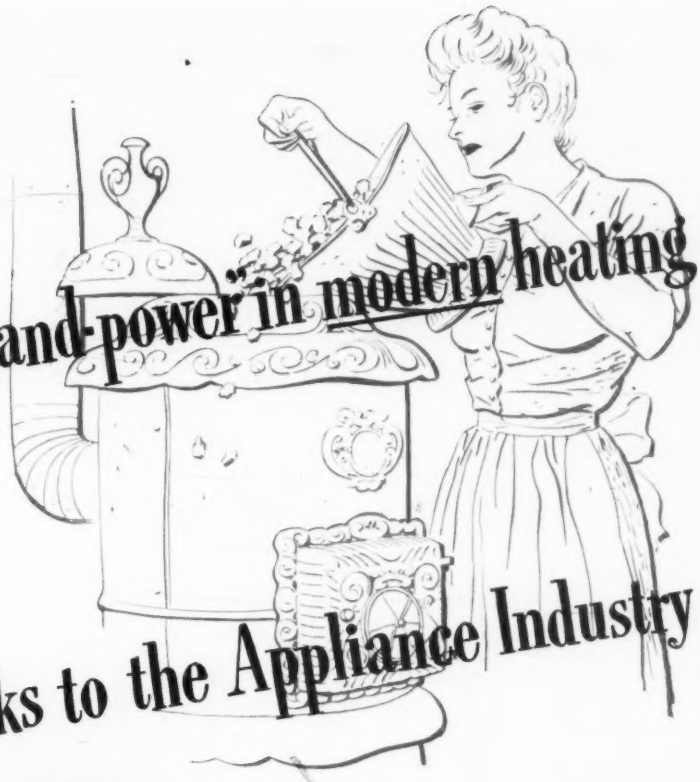
CUSTOM-BUILT TANKS, HOUSINGS, HOODS, FENDERS, CONTINUOUS HINGES, CABINETS, AND OTHER SHEET METAL PARTS AND ASSEMBLIES

Write for this book.

It outlines advantages of Stolper services.

Use STOLPER *as* YOUR SHEET METAL DEPARTMENT

There's no "hand-power" in modern heating



. . . thanks to the Appliance Industry

Americans have *many* reasons to be grateful to the appliance industry. For much of the ease, the convenience and the healthfulness of modern American life is due to modern American appliances. Delco Products is proud of its part in this great industry. Many of the first models of famous appliances were powered by especially developed Delco Motors. And as these products have been consistently improved, so Delco Motors have been made ever more efficient and dependable. Built in sizes from 1/8 to 50 h.p., Delco Motors are quiet, compact and designed to fit the requirements of the particular application. Delco Products Division, General Motors Corporation, Dayton, Ohio.

DELCO PRODUCTS DAYTON, OHIO

UPSET AND FLANGED
INSERT SPOTWELDED
SWAGE TAPERED
UPSET AND FLARED
"Standard" Tubing Techniques
Apply the Versatility of "Standard" UPSET FORGING to Your Product
The upset forging facilities and techniques at "Standard" make possible this one-piece tube. Starting with a 3.4 O.D. by .134 wall tube, upset and flanged at one end to 5.12 O.D. by .520 thickness—tapered at opposite end to 2.240 O.D. and belled to 4.65 O.D. with .320 wall thickness—separate forgings and welding operations are unnecessary.
Specify STANDARD—It Pays!
THE STANDARD TUBE CO.
Detroit 28, Michigan
Welded Tubing
Fabricated Parts
STANDARDIZE with STANDARD — It Pays
Sizes ½" O.D. to 5½" O.D., 22 S.W.G. to 3 S.W.G.

When you want a COMMAND PERFORMANCE in spring steel

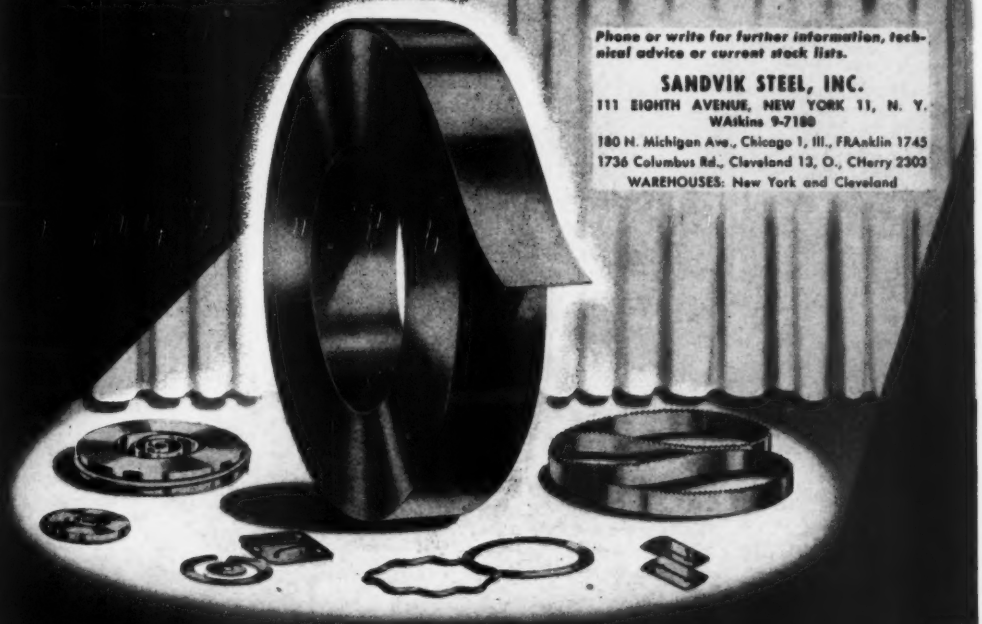
. . . Check with Sandvik

When you have an application that demands a specific type of high quality spring steel performance, consult SANDVIK.

SANDVIK produces a wide variety of spring steels; each a specialized performer for a specific type of service. By analysis and processing, SANDVIK controls the physical characteristics that give each of these steels its special ability. That's why SANDVIK can supply you with a steel that will fit your requirements "like a glove."

You can obtain SANDVIK, cold-rolled, high-carbon and alloyed strip steels:

- *In special analyses for specific applications*
- *Annealed, unannealed or hardened and tempered*
- *Precision-rolled in thicknesses from .001"*
- *With bright finish or polished bright, yellow or blue*
- *With round edges or square edges*
- *In a wide range of widths*



Phone or write for further information, technical advice or current stock lists.

SANDVIK STEEL, INC.
111 EIGHTH AVENUE, NEW YORK 11, N. Y.
WAtkins 9-7180
180 N. Michigan Ave., Chicago 1, Ill., FRAnklin 1745
1736 Columbus Rd., Cleveland 13, O., CHerry 2303
WAREHOUSES: New York and Cleveland

SS-37

SOME SANDVIK SPECIALTY SPRING STEELS: Band Saw Steels: Metal Band, Wood Band and Spring Temper • Camera Shutter Steel • Clock and Watch Spring Steels • Compressor Valve Steel • Doctor Blade Steel • Feeler Gauge Steel • Flapper Valve Steel • Knife Steels • Razor Blade Steel • Reed Steel • Shock Absorber Steel • Sinker Steel • Spring Steels • Textile Steels • Trowel Steel • Vibrator Reed Steel

Quantity PRODUCTION *of* GREY IRON CASTINGS

ONE OF THE NATION'S LARGEST AND MOST MODERN PRODUCTION FOUNDRIES

ESTABLISHED 1866

THE WHELAND COMPANY

FOUNDRY DIVISION

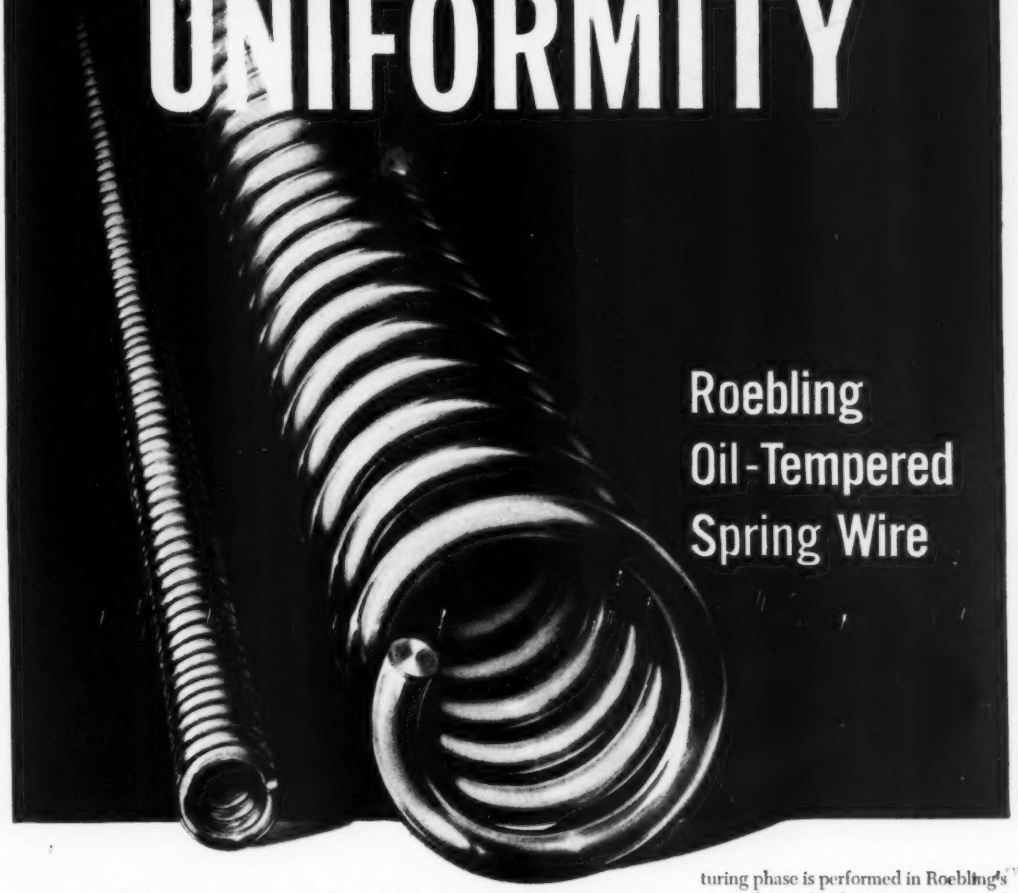
MAIN OFFICE AND MANUFACTURING PLANTS

CHATTANOOGA 2, TENNESSEE

JR ROEBLING

HERE'S EXTRA VALUE... PROFITABLE

UNIFORMITY



CUTS MACHINE STOPPAGES AND REJECTS

PRODUCTION GOES INTO HIGH with Roebling Oil-Tempered Spring Wire. Every inch is just like every other inch . . . same gauge and grain structure . . . same strength, hardness and finish. And more than that, the dependably uniform analysis of Roebling Spring Wire enables you to maintain your specified quality standards without variation.

Roebling Oil-Tempered Spring Wire, in the higher carbons, is available in all standard sizes. From making the steel to the finished product, every manufacturing phase is performed in Roebling's own plants. Modern equipment and techniques assure wire of topmost quality . . . and it's available now!

Your Roebling Field Man will be glad to help you select the right wire—round, flat or shaped—for top performance and economy in your own products. John A. Roebling's Sons Company, Trenton 2, New Jersey.

WRITE OR CALL THE ROEBLING FIELD MAN AT YOUR NEAREST ROEBLING OFFICE AND WAREHOUSE

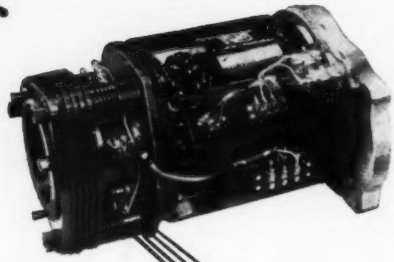
Atlanta, 934 Avon Ave. ★ *Boston*, 51 Sleeper St. ★ *Chicago*, 5525 W. Roosevelt Rd. ★ *Cleveland*, 701 St. Clair Ave., N. E. ★ *Denver*, 1635 17th St. ★ *Houston*, 6216 Navigation Blvd. ★ *Los Angeles*, 216 S. Alameda St. ★ *New York*, 19 Rector St. ★ *Philadelphia*, 12 S. 12th St. ★ *Pittsburgh*, 855 W. North Ave. ★ *Portland, Ore.*, 1032 N. W. 14th Ave. ★ *San Francisco*, 1740 17th St. ★ *Seattle*, 900 First Ave.

ROEBLING

☆ A CENTURY OF CONFIDENCE ☆

FIBERGLAS*

...helps provide dependable finger-tip control

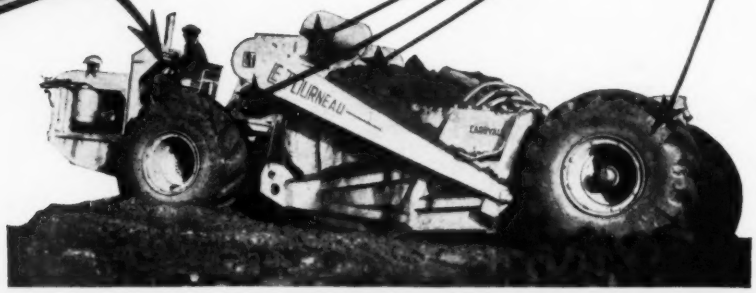


Moving tons of earth in a hurry is an easy job with LeTourneau Tournapulls. Easy — because they're operated by finger-tip control. Just a flick of a switch is all that is required to start electric motors that load, steer, turn and empty these giant earth movers. And *dependable* motors are highly important in this automatic operation because these machines work under the toughest weather conditions. That's why LeTourneau provides added protection by using motors insulated with Fiberglas-base Electrical Insulating Materials.

Other leading designers and engineers have found it's good insurance to have the added protection of Fiberglas-base Insulations. They've found, too, that these inorganic-base materials have helped solve problems such as the need for reduction in motor size, resistance to the effects of heat, overload, moisture, most corrosive acids and vapors, dust and many other causes of motor insulation failures. If you have a motor insulation problem, get more information about the advantages of these dependable materials by writing to Owens-Corning Fiberglas Corporation, Department 807, Toledo 1, Ohio, today for your copy of the "Fiberglas Electrical Insulating Materials" manual. Branches in principal cities.

In Canada: Fiberglas Canada Ltd., Toronto, Ontario.

LeTourneau Tournapulls, equipped with Fiberglas-insulated motors, generators and transformers, are manufactured by R. G. LeTourneau Inc., Peoria, Illinois.



OWENS-CORNING
FIBERGLAS
Tm. REG. U.S. PAT. OFF.

ELECTRICAL INSULATING MATERIALS

MEASURING SATISFACTORY PERFORMANCE

. . . IN EVERY TEST!

QUAKER PACKINGS ARE "PRE-TESTED" TO ASSURE PERFECT FIT, LONG LIFE, MAXIMUM EFFICIENCY

Packings to be efficient must be perfect in fit . . . must form a tight seal in pumps, flanges, valve stems, piston rods to prevent leaks . . . must be of exact quality to meet the operating requirements of specific conditions.

That's why Quaker Packings are "pre-tested." Carefully calipered for size and fit . . . painstakingly checked for quality. Above we see the final test, one of many pre-tests Quaker Packings must go through before they are ready for usage. Tests that are safeguards against costly leaks, troublesome shutdowns, loss of production.

There's a Quaker packing for every type of service—water, air, gas, oil, acids at extreme temperatures . . . all pre-tested for better performance.

HOSE THAT LASTS

. . . because it has been pre-tested to stand pressure and resist wear. Quaker Hose is available for use with air, water, steam, volatiles, acids and gases.

FOR PEAK HORSEPOWER

Quaker belts are pre-tested for every industrial need . . . belts of all kinds that assure peak efficiency under all operating conditions.

QUAKER RUBBER CORPORATION

PHILADELPHIA 24, PA. • New York 7 • Cleveland 15 • Chicago 16 • Houston 1
Western Territory
QUAKER PACIFIC RUBBER CO. • San Francisco 10 • Los Angeles 21 • Seattle 4

QUAKER

RUBBER PRODUCTS

•

QUAKER RUBBER CORPORATION PHILADELPHIA, PA. QUALITY SINCE 1885

REG. U. S. PAT. OFF.

No. 3 in a series of performance case histories

Grant REDUCER in use 20 years . . . NOT A PENNY SPENT ON MAINTENANCE

. . . H & P Spool and Bobbin Co., Lawrence, Mass., gives the details of another great performance story:

H & P SPOOL & BOBBIN COMPANY

LAWRENCE, MASSACHUSETTS

Early in 1928 we installed a Grant 5⅝" Model B Worm Gear Reduction Unit as the driving medium on a horizontal conveyor. This Unit gave a reduction in speed of 33 - 1, power being supplied by a 2 H.P., 1200 R.P.M. Motor directly connected to the reduction unit by a flexible coupling. This Unit has operated approximately thirty hours per week since installation, without attention or repair except for regular cleaning and lubrication. A good record for a good unit.

Performance stories like the one above don't "just happen". Grant Reducers perform years longer without maintenance because they are designed and built from the finest materials with utmost precision. All Grant Reducers are equipped with radial thrust ball bearings, oil seals, gears of high test bronze, worms of chrome vanadium steel and many others.

Grant Gear Works, Inc.,
000 West Second Street
So. Boston 27, Mass.

Decide now to cut maintenance costs in your plant — install Grant Reducers for long trouble-free service.

WRITE TODAY FOR FREE CATALOGUE

1877 – GEARED TO INDUSTRY'S NEEDS FOR 71 YEARS – 1948

Grant SPEED REDUCERS

7 gear arrangements — hundreds of ratios

WITTEK Hose Clamps

FBSS Clamp

HP Clamp

Clamp on Hose

Worm Drive Clamp

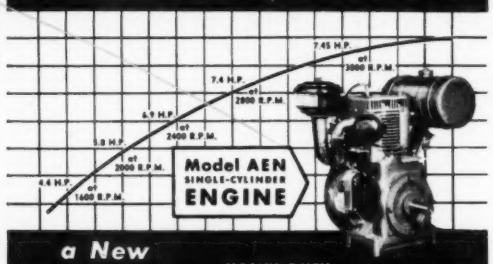
A Clamp

For Quick-Tightening Leakproof Hose Connections

Product and design engineers can look to WITTEK to help solve their hose connection problems. Wittek Hose Clamps, for over a quarter century known as standard equipment in the automotive and aviation industries, are today widely used on machines, engines and equipment requiring leakproof hose connections for air, oil, gas and water lines. Consult us on your hose clamping problems. Write for Literature.

WITTEK MANUFACTURING CO.
4305-15 W. 24th Pl. Chicago 23, Ill.
Hose Clamps for Every Application

ANOTHER POWER ACHIEVEMENT



a New **WISCONSIN** HEAVY-DUTY *Air-Cooled* **ENGINE**

Lower cost, more horsepower at normal speeds . . . less weight! Already, manufacturers and users alike are praising these features of the new heavy-duty air-cooled AEN 7½ hp. single-cylinder engine.

As shown, it develops peak horsepower well within normal speeds, yet weighs only 126 pounds . . . less than any comparable engine.

Advanced engineering design alone is responsible for the added power, decreased weight and lower cost per delivered horsepower. Every part is machined to traditional close tolerances. Every service-proved, heavy-duty feature still remains . . . Timken tapered roller-bearings *at both ends* of the crankshaft; jet and spray oiling, etc.

Write today for additional data. Other Wisconsin Air-Cooled Engines available in Single Cylinder, 2-Cylinder and 4-Cylinder Models, 2 to 30 hp.

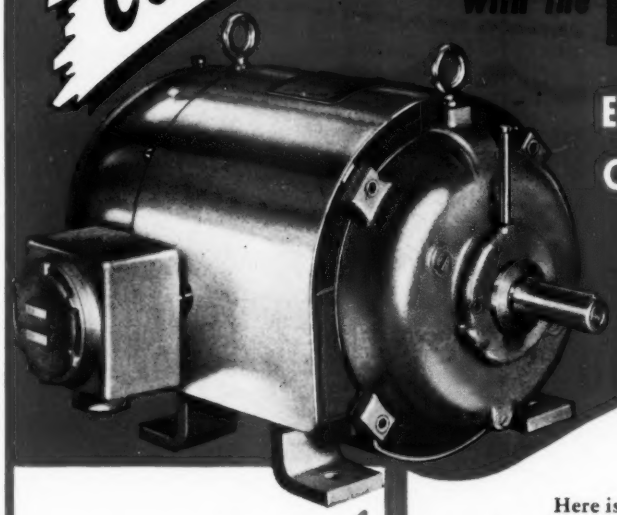
MOST H.P. HOURS

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 14 WISCONSIN

COMPLETE INSURANCE

with the **RELIANCE**

EXPLOSION-PROOF and CORROSION-RESISTING MOTOR



Selected Materials and Design Features

OFFER MAXIMUM PROTECTION!

FOR CORROSIVE ATMOSPHERES

The Totally-Enclosed Fan Cooled A-c. Motor for Applications where Chemical Atmospheres Prevail

and

FOR ATMOSPHERES CONTAINING HAZARDOUS GAS OR INFLAMMABLE LIQUIDS

Underwriters' Class 1, Group D Explosion-Proof A-C. Motor

Here is the result of Reliance engineering applied to the problem of protecting motors that operate in either corrosive or explosive atmospheres. Frame and fan covers, fan, conduit box and end brackets are all made of selected corrosion-resisting materials. In addition, many extra steps are taken to achieve maximum protection, such as coating screws, counterboring screw holes and fitting-up with special compounds.

Reliance *Precision-Built* Motors offer you the *right* motor for any application. For further information about this explosion-proof, corrosion-resisting motor, write for Bulletin C-130.

Sales Representatives ***in Principal Cities***

RELIANCE ELECTRIC AND ENGINEERING CO.

1080 IVANHOE ROAD • CLEVELAND 10, OHIO

PRESSURE LOADING

in a hydraulic pump

...provides volumetric efficiencies up to 97%!...provides torque efficiencies up to 90%!
...assures these efficiencies over a longer service life!

ONLY Pesco HYDRAULIC PUMPS GIVE YOU PRESSURE LOADING

This booklet explains PRESSURE LOADING . . . write for your copy today.

Pressure Loading is a Pesco patented principle of hydraulic pump design which utilizes pressure from the discharge of the pump to maintain a minimum end clearance between gear and bearing faces. This automatically compensates for wear.

Pesco hydraulic pumps with ***Pressure Loading*** will not "freeze" under normal load conditions. They have an unusually long service life. They require minimum maintenance. Do not require micrometer fits. They guarantee highest possible efficiencies under all operating conditions.

Only Pesco hydraulic pumps have ***Pressure Loading***. If the design of your product calls for the use of hydraulic pumps . . . or other hydraulic equipment . . . it will pay you to send for your copy of the free booklet, "Pressure Loading by Pesco".

OTHER ADVANTAGES OF PESCO PRESSURE LOADED HYDRAULIC PUMPS

1. Provides uniform rate of fluid flow regardless of variations in load, in viscosity of hydraulic fluid, or in temperature.
2. Permits use of smaller pump for a given installation.
3. Accomplishes more work per unit of energy expended.

Pesco PRODUCTS DIVISION
BORG-WARNER CORPORATION
11610 Euclid Ave. - Cleveland 6, Ohio

MANUFACTURERS OF BW SUPERCHARGERS

Speed Production and Cut Costs with OSTUCO "tailor-made" tubing

No matter what your product, there's a good chance you can make it faster, better and at lower cost by using OSTUCO "tailor-made" tubing. OSTUCO prefabricates tubing to your exact blueprint requirements . . . eliminates from your production problems all threading, angle cutting, shaping, flattening and many other operations which can be performed most efficiently and economically on our fast, modern machines. This enables you to more profitably concentrate your efforts on assembly and other phases of manufacture . . . strengthens your competitive position through increased output and wider profit margin. Write direct or to our nearest Sales Office for free booklet "OSTUCO Tubing and Facilities."

WHAT'S YOUR PRODUCT?

KITCHEN RANGES

Slash production costs and increase the beauty and practicality of your door handles by using steel tubing—Ostuco tubing fabricated to your own specifications. Ostuco will cut, burr, bend, expand, and roll the ends, and deliver the tubing in insert assembly, relieving you of many bothersome production details and increasing the sales appeal of your ranges.

LAWN CARTS

Save time, save labor, save money by having your tubing delivered all ready for assembly. Bending, flattening, drilling, external beading—all of these complicated forming and fabricating operations are handled in fast, mass production at Ostuco, thus providing you with short cuts to higher volume and lower cost.

OSTUCO

THE OHIO SEAMLESS TUBE COMPANY

Plant and General Offices: SHELBY 7, OHIO

Sales Offices: CHICAGO, Civic Opera Bldg., 20 North Wacker Dr. CLEVELAND, 1328 Citizens Bldg. • DAYTON, 1517 E. Third Street DETROIT, 2857 E. Grand Blvd. • HOUSTON, 927 A M&M Bldg. LOS ANGELES, Suite 300-170 So. Beverly Drive, Beverly Hills • MOLINE, 617 15th St. • NEW YORK, 70 East 45th St. • PHILADELPHIA, 1413 Packard Bldg., 15th & Chestnut • ST. LOUIS, 1230 North Main St. • SEATTLE, 3205 Smith Tower • SYRACUSE, 501 Roberts Ave. CANADIAN REPRESENTATIVE: Railway & Power Corp., Ltd., HAMILTON, MONTREAL, NORANDA, NORTH BAY, TORONTO, VANCOUVER and WINNIPEG.

Only Houghton . .

The One Source For All Your Moulded Packing Needs!

Customers tell us they prefer to deal with a supplier who can furnish *all* types of moulded packings, and who will therefore make an impartial recommendation to suit individual requirements.

Houghton is, we believe, the only large manufacturer which supplies leather and synthetic rubber packings, both fabricated and homogeneous, including "O" rings.

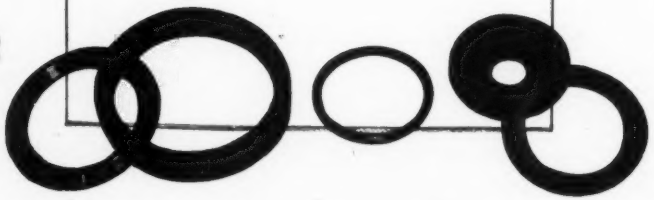
Also, Houghton through its Oil Department supplies Hydro-Drive Hydraulic Oil, fortified to resist oxidation, corrosive tendencies or gum formations.

Add to this our engineering experience on which designers and engineers rely, and you'll see why Houghton rates so high in hydraulics. Can we help you on some current packing problem?

E. F. HOUGHTON & CO.

303 W. Lehigh Ave., Phila. 33, Pa.

VIM LEATHER
and
VIX-SYN RUBBER
Engineered
PACKINGS



ASK STOKES

70% Labor Saving with Automatic Molding

Savings of 70% in labor costs were made by a custom molder when he used a Stokes completely automatic plastics molding press.

Previously he had used a conventional semi-automatic press with preformer and preheater. He produced the souvenir ash tray (illustrated) on a two-cavity mold at a total labor cost of $17.00 per thousand finished pieces.

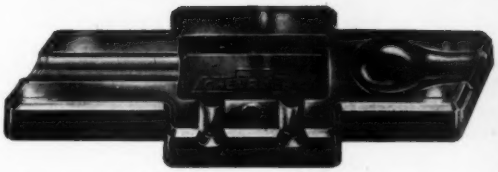
Now, using a Stokes automatic 50-ton press, with a single cavity mold, he produces the same ash tray for a labor cost of $5.10 per thousand pieces . . . a saving of $11.90 per thousand for labor alone. These are his figures, *not ours*.

And further major savings resulted from using the high-production single-cavity mold, instead of the former higher-cost multi-cavity mold.

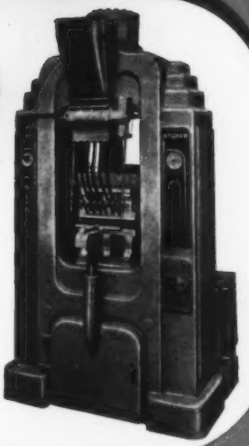
If you want to know what automatic molding can save you, send your own samples or blueprints to Stokes for free analysis.

F. J. Stokes Machine Company,
5900 Tabor Rd., Phila. 20, Pa.

Stokes makes Semi-Automatic and Automatic Molding Presses, Plunger Presses, Closure Presses, Preforming Presses, Industrial Tabletting and Powder Metal Presses, Vacuum and Special Processing equipment, Water Stills and Special Machinery.



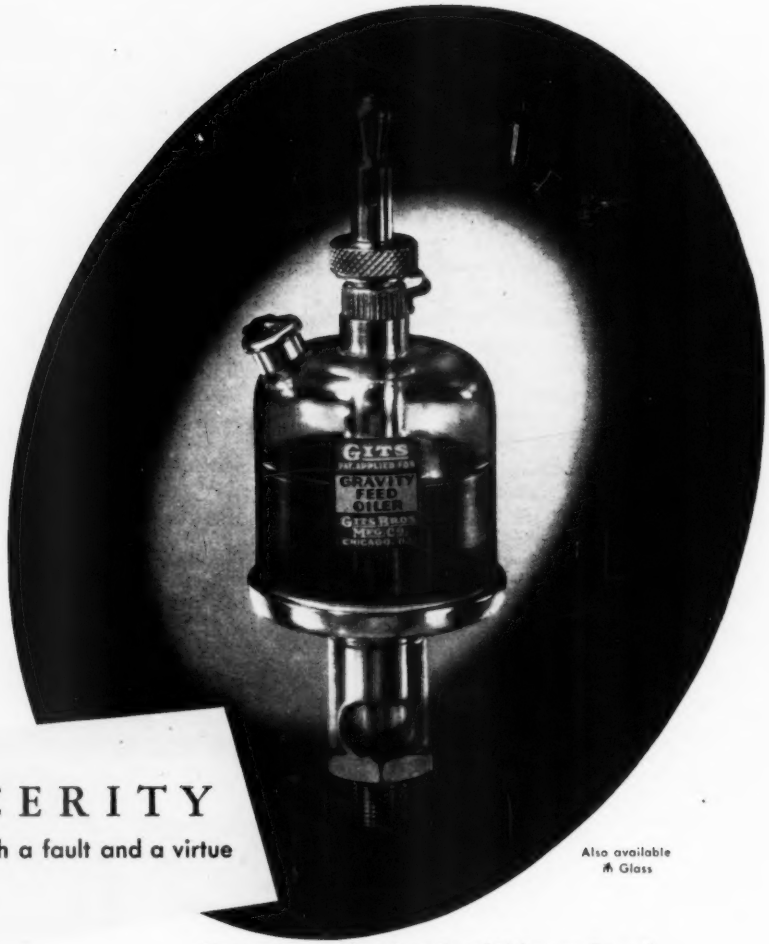
This souvenir ash tray was produced at a 70% saving in labor cost on a Stokes Automatic Molding Press, similar to Model 235A, illustrated here.



Condensed Press Specifications, Model 235A

Maximum Press Capacity (Tons) . . .	50
Maximum Stroke (Inches)	14
Upper and Lower Platens (Inches) .	14 x 7
Feeding Device – Chambers	6
Capacity per feeding chamber. (Cu. In.)	⅛ min. - 4 max.

STOKES KNOWS HOW



SINCERITY

has proved both a fault and a virtue

Also available
in Glass

Sincerity in upholding the policy of highest quality and the claims of superiority, has interfered with meeting the constantly increasing demand for GITS Visible Oilers in a limited way.

NOW —

—reconversion, standardization and improved facilities, plus the engineering "know-how" of more than 40 years in both war and peacetime development of lubricating devices, gives you Genuine GITS Visible Oilers in both *the highest quality* and in *any desired quantity.*

GITS Visible Oilers are featured in Wick Feed, Vibrating Rod, Constant Level, Sight Gravity Feed and unmodified transparent bottle types.

GITS has been "Friction-Fighting Headquarters" for more than 40 years and always will be— bring your problems to GITS.

Write for information

GITS BROS. MFG. CO.

1638 S. Kilbourn Ave., Chicago 23, Illinois

Now... Top Quality Motors Available in Quantity

PACKARD SUNLIGHT MOTORS

PACKARD SUNLIGHT MOTORS
for
compressors
washing machines
power-driven
bench tools
ironers
milk separators
milking machines
furnace blowers
stokers
oil burners
water pumps
ventilators
and many other
applications

Increased availability of Packard Sunlight Motors means increased opportunity for you to build lasting consumer satisfaction into your motor-driven appliances and equipment. A new plant and new production facilities assure a steady supply of these dependable, efficient power units for both new and old customers. Profit now from the value, the trade acceptance, the prestige that Packard Sunlight Fractional Horsepower Motors will give your products.

Packard

Packard Electric Division, General Motors Corporation, Warren, Ohio

DEPENDABLE APPLIANCE MOTORS FOR THIRTY-TWO YEARS

Reducing Diet for . . . *inflated costs!*

Want to trim your product costs down to neat, tidy figures? Then feed your production equipment a diet of *pre-coated* Thomas Strip.

For, this ready-to-use strip steel runs smoothly *at top speed* through progressive dies and intricate forming rolls . . . feeds freely, with fewer shutdowns . . . hikes your production rates and holds rejects to welcome low levels.

It helps stretch die life, too. Most Thomas coatings—brass, copper, zinc, lead alloy or tin—reduce die wear and give you more production per grind. And, they can serve as the final finish for your product, or may be used as a ready base for further plating or painting. Cost-cutting products are listed below.

THE THOMAS STEEL COMPANY
WARREN, OHIO

Specialists in Cold Rolled Strip Steel

Electrocoated with Zinc, Copper, Nickel and Brass • Hot Dipped Tin and Lead Alloy • Lacquer Coated in Colors • Spring Steel • Alloy Steel • Produced to Your Specifications

Improves Quality . . . Cuts Parts Costs

NEWARK

DESIGN and PRODUCTION of WOVEN WIRE PARTS

NEWARK for ACCURACY

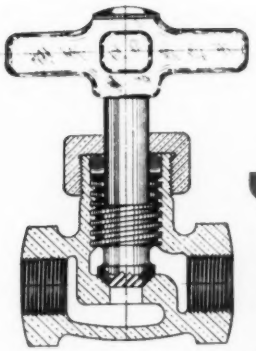
Why not allow us to do a "from start to finish" job on your fabricated wire cloth parts? What do we propose to do? Assist you with the design, set up the necessary tooling, make the wire cloth . . . it's the well known Newark Wire Cloth long noted for its accuracy and durability . . . and do all the necessary cutting, stamping, punching, welding, soldering, seaming and bending. We deliver to you a finished product in any quantity desired. We are equipped to handle your requirements on a quantity production basis.

May we quote on your next requirements?

* * *

We also manufacture a complete line of industrial wire cloth in all commercial malleable metals.

Newark Wire Cloth COMPANY
VERONA AVENUE • NEWARK 4, NEW JERSEY

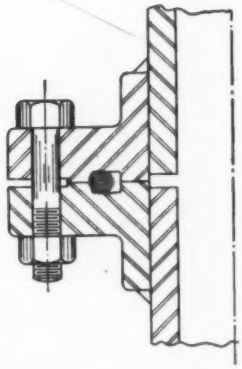


SHOWER VALVE

LINEAR "O" rings eliminated cap gasket and materially reduced packing wear and replacement.

"O" RINGS ARE VERSATILE*

These are a few examples of the constantly increasing number of applications where LINEAR "O" rings are simplifying designs and cutting production costs. For highly specialized conditions, LINEAR is successfully moulding "O" rings of Kel-F, Teflon and Silicone. Available is a long list of natural or synthetic rubber compounds adaptable to a wide range of temperatures, gases and liquids. LINEAR engineering experience is at your disposal —send full details and copies of your blueprints.

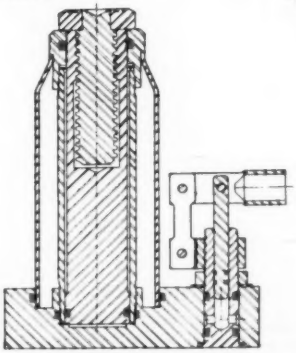


FLANGE UNION

With flange bolts stressed to resist separating force at maximum pressure, LINEAR "O" rings make positive liquid or gas-tight seals and are unaffected by vibration.

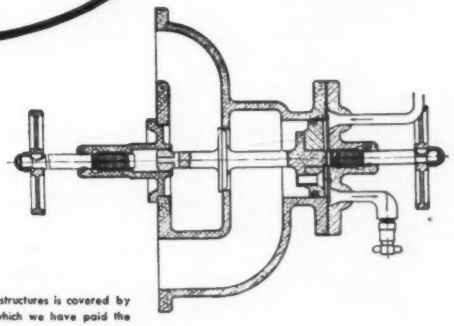
HYDRAULIC JACK

LINEAR "O" rings eliminated 14 parts and increased service life 100%.



RELIEF VALVE

LINEAR "O" rings enabled the manufacturer to eliminate 5 parts and effect savings of 22.4% in production costs.



* The use of "O" rings in certain packing structures is covered by Christensen Pat. No. 2,180,795 under which we have paid the royalty for the installation of our rings in these structures so that the royalty is included in the purchase price of the "O" ring.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

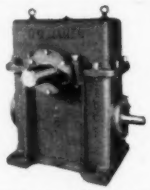
LINEAR, Inc., STATE ROAD & LEVICK STREET, PHILADELPHIA 35, PA.

D.O.James

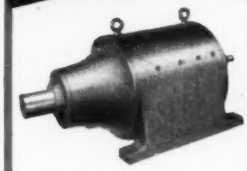
ESTABLISHED 1888

GEARED DRIVES MEET GROWING DEMANDS FOR POWER-SAVING EQUIPMENT IN INDUSTRY

Continuous-tooth Herringbone
Single, Double, Triple Reduction

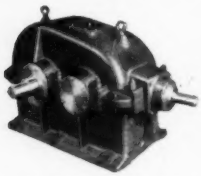


Type "H" Worm Gear

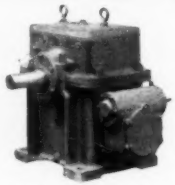


Straight Line Gear Reducer

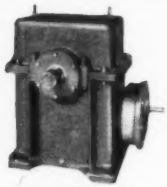
Motorized Reducers



Spiral Bevel Herringbone



Double Worm Gear



Helical Worm Gear

Motorized Worm Gear

Right Angle Gear Reducer

Spiral Bevel Gear

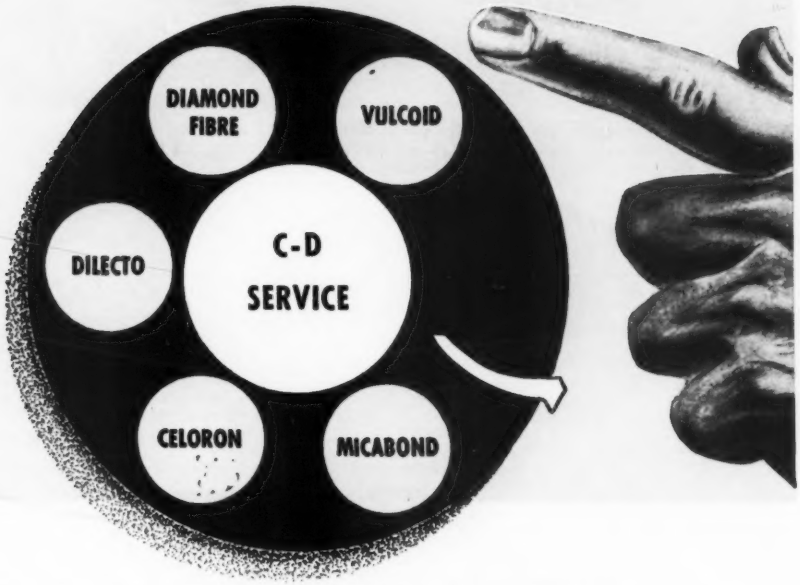
D.O.James Gear Manufacturing Co. is constantly developing and continuing to improve its variety of gear speed reducers—enabling engineers and designers of power-saving equipment to meet and cope with space limitations, horsepower requirements, ratios, location of driven or driving shafts and the type of drive that the many and varied installations require. Catalogs are available containing complete informative engineering data that will assist in the selection of the type of reducer for the specific job to be done.

D.O.JAMES GEAR MANUFACTURING CO.

Since 1888—Makers of Cut Gears, Gear Reducers and Flexible Couplings

1140 W. MONROE STREET • CHICAGO, U. S. A.

The right material for your job
. . . right at your fingertips!



How to Save Production Hours and Dollars on Your Electrical Insulating Jobs . . .

One of the surest ways to reduce unit costs on any job is to be right the first time when selecting materials. Continental-Diamond's complete line of high strength electrical insulating materials makes proper product engineering easy.

There are trained C-D technicians on hand at all times to give you personal help in getting better, lower-cost applications. To be sure of being right the first time in the selection of materials, call your nearest C-D office whenever the need arises.

C-D HIGH-STRENGTH PLASTICS

DIAMOND FIBRE—Vulcanized Fibre.
VULCOID—Resin Impregnated Fibre.
DILECTO—Laminated Thermosetting Plastic.
CELORON—Molded High-Strength Plastic.
MICABOND—Bonded Mica Splittings.

DE-4-48

BRANCH OFFICES: NEW YORK 17 • CLEVELAND 14 • CHICAGO 11 • SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES
WEST COAST REPRESENTATIVE: MARWOOD LTD., SAN FRANCISCO 3 • IN CANADA: DIAMOND STATE FIBRE CO., OF CANADA, LTD., TORONTO 8

Continental-Diamond FIBRE COMPANY
Established 1895 . . Manufacturers of Laminated Plastics since 1911—NEWARK 40 • DELAWARE

The practical answer to longer appliance utility & safety...

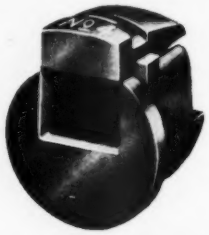
HEYCO

STRAIN RELIEF BUSHING

Molded of NYLON

WILL ANCHOR THE CORD SET TO YOUR ELECTRICALLY OPERATED MACHINES, EQUIPMENT & APPLIANCES

In Canada Approved by Canadian Standards Association #9919



IT'S EASY TO APPLY THE HEYCO

1. Slip Heyco on wire
2. Snap Heyco into chassis hole

Look what HEYCO does!

1. ABSORBS CORD PULL, PUSH AND TORQUE
2. INSULATES WIRE FROM CHASSIS
3. PREVENTS WIRE FROM FRAYING
4. ELIMINATES TYING WIRE KNOTS

● The Heyco is a Nylon insulating grommet that grips the wire in a vise-like grip in addition to insulating the wire from the chassis. It does not injure the wire yet it anchors it firmly to the product, thus preventing strain on terminals. Heyco eliminates cord wear at chassis entrance and is available with spring extension for applications requiring wire movement. Illustrated Bulletin on request.

HEYMAN MANUFACTURING COMPANY
KENILWORTH 3, N. J.

And it improves

Product Appearance

at low cost!

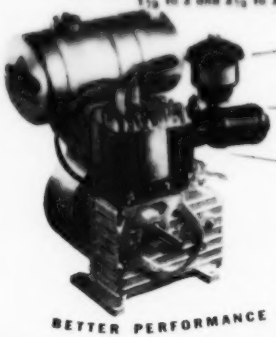
TEST SAMPLES SENT ON RECEIPT OF WIRE SPECIFICATIONS

HEYCO ELIMINATES STRAIN ON TERMINALS

Purr-r *With Power!*

ULTIMOTOR

1½ to 2 and 3½ to 3 H. P.



BETTER PERFORMANCE PER DOLLAR!

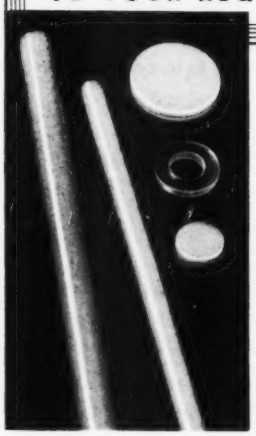
Engineered for increased efficiency. Smoother running, with its centrifugal type governor, its geared pump with forced feed and splash oil system. More dependable power, with a high-tension crankshaft magneto. ULTIMOTOR is precision machined, lighter and more compact than most engines of lower rating, its outstanding performance proven by on-the-job comparison.

For Full Information Write Box P E

Write For NEW Direct Factory-Dealer Plan

UEBELHOER BROS., Inc.
848 KENSINGTON AVE., BUFFALO 15, N. Y.

NYLON . . MOLDED TO YOUR REQUIREMENTS



VALVE SEAT DISCS
in FM-10001 (Rigid) Nylon

VALVE WASHERS
in FE-1044 (Semi-Rigid) Nylon

CONTRACT NYLON MOLDING
We have the set-up and the experience to give you the best in nylon parts molding in small or large quantities.

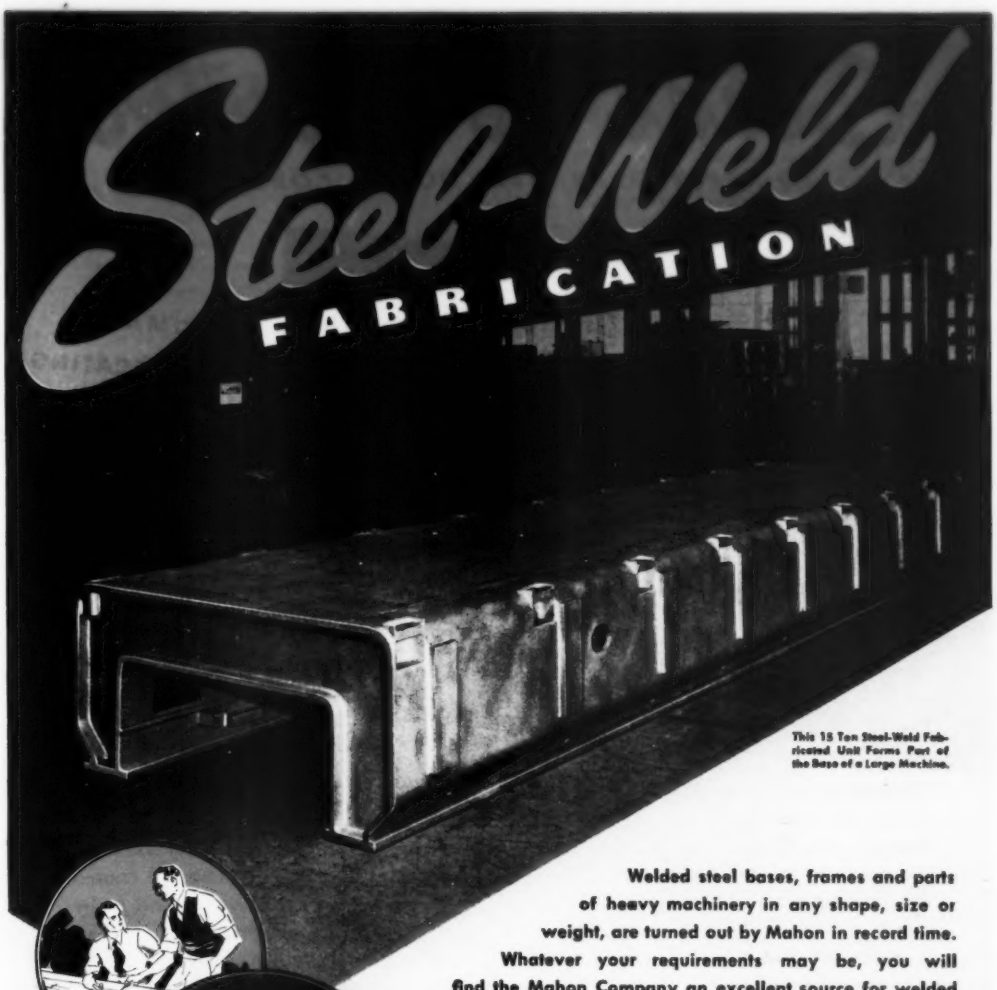
SEND FOR QUOTATIONS ON SPECIFIC REQUIREMENTS

NYLON RODS
FOR IMMEDIATE DELIVERY
in ¼", ⅜" and ½" diameters and 8¼" lengths in FM-10001 Nylon. Quantity prices on request.

S.S.WHITE PLASTICS DIVISION
THE S. S. WHITE DENTAL MFG. CO. — DEPT. DP, 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS AND ACCESSORIES
MOLDED PLASTICS PRODUCTS—MOLDED RESISTORS

Steel-Weld FABRICATION



This 15 Ton Steel-Weld Fabricated Unit Forms Part of the Base of a Large Machine.

Welded steel bases, frames and parts of heavy machinery in any shape, size or weight, are turned out by Mahon in record time.

Whatever your requirements may be, you will find the Mahon Company an excellent source for welded steel in any form . . . a source equipped to provide complete machining service on any Steel-Weld fabricated parts or products regardless of size or weight. Mahon's staff of thoroughly competent design engineers, backed by craftsmen highly skilled in the latest techniques in the welding art, are your assurance of a better, smoother appearing job, embodying every advantage of Steel-Weld Fabrication.

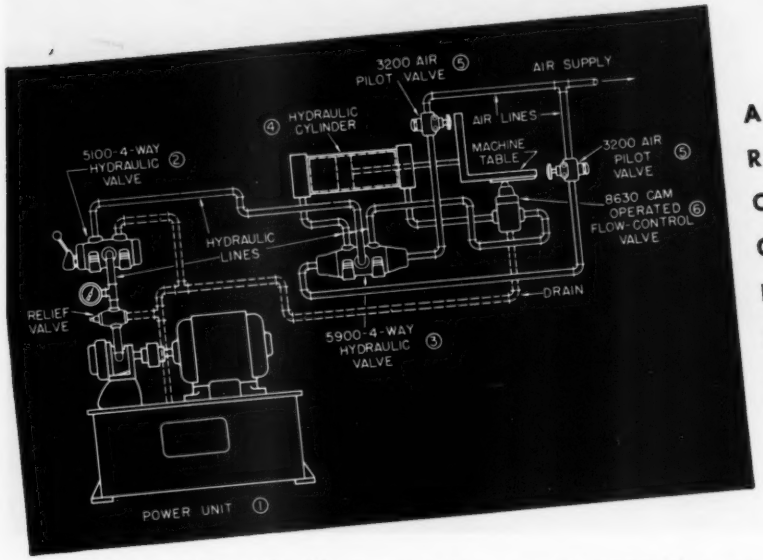
THE R. C. MAHON COMPANY
DETROIT 11, MICHIGAN

Engineers and Fabricators of Welded Steel Machine Bases and Frames, and Many Other Welded Steel Products

MAHON

Count on Gerotor

TO APPLY HYDRAULIC POWER CORRECTLY



AUTOMATIC RECIPROCATING CIRCUIT FOR CONTROLLED FEED OF MACHINE TABLE

Shifting model 5100 (2) control valve allows oil from pump unit (1) to pass through model 5900 (3) pilot operated control valve to the blind end of cylinder (4), causing piston to move forward. As cam of model 8630 (6) flow control valve is depressed, the required rate of speed of forward stroke is obtained. When model 3200 (5) pilot valve is contacted, pilot pressure shifts model 5900 (3) pilot valve, and cylinder travel reverses. To stop table, shift model 5100 (2) control valve to original position and oil is by-passed to tank at zero pressure. Use cushioned cylinders when piston velocities and inertia of connected loads are high.

3 helps GEROTOR offers for correct application of hydraulic power

1 EXPERIENCED DISTRIBUTORS
qualified to solve your circuit problems. Located in all principal cities.

2 COMPLETE LINE
air and hydraulic valves and cylinders; hydraulic pumps, pump units and hydraulic motors.

3 INFORMATIVE LITERATURE
to help you lay out air and hydraulic circuits to meet your requirements.

Write to GEROTOR MAY CORPORATION, DEPT. PE-2, BALTIMORE 3, MD.

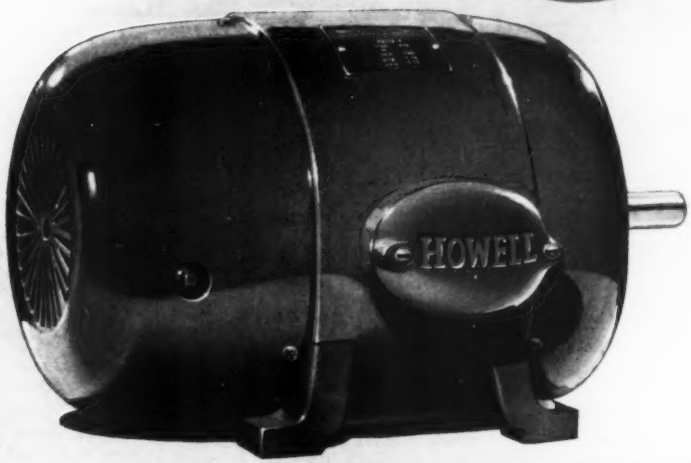
WHEN YOU APPLY HYDRAULIC OR AIR POWER *Plan with* **GEROTOR**

HOWELL *industrial type* MOTORS

MECHANICAL CONSTRUCTION

- General-purpose, drip-proof
- Splash-proof
- Totally-enclosed
- Totally-enclosed, fan-cooled
- Explosion-proof
- Dust-proof
- Sanitary
- Specials—round body, vertical, flange and face mounting, built-in stator and rotor jobs, etc.
- Motor-generator sets for frequency changing

RED BAND MOTORS
HOWELL
SINCE 1915



Here's a complete line of industrial type motors you'll want to investigate.

For your *industrial* motor needs, choose an *industrial type* motor. The Howell Line of AC Motors comprises geared motors, motors with unique electrical characteristics, special mechanical form, or standard motors with any type enclosure from 1/6 through 150 H.P. Consult HOWELL!

PERFORMANCE CHARACTERISTICS

SINGLE PHASE

- Capacitor start, high torque
- Capacitor start and run, high torque
- Capacitor start and run, low torque

POLYPHASE

- Normal torque, normal starting current
- Normal torque, low starting current
- High torque, low starting current
- Medium slip, as for punch press
- High slip smooth acceleration (elevators, hoists, etc.)
- Multi-speed
- Slip-ring
- Intermittent duty
- Torque motors
- Special performance, high temperature duty, etc.
- Rapid reversing

HOWELL ELECTRIC MOTORS CO., HOWELL, MICHIGAN

MANUFACTURERS OF PRECISION BUILT, INDUSTRIAL TYPE MOTORS

Wide Base General Industrial Pneumatics

SAVE TIME • MONEY • LABOR

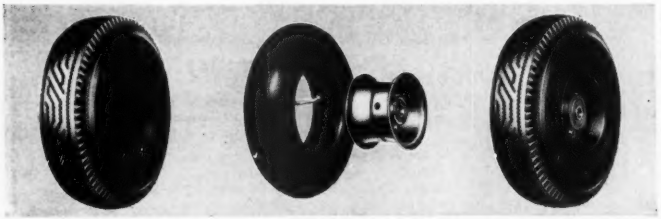
General Industrial Tire 16" Overall Diameter on Wide-Base Rim

Conventional Tire 16" Overall Diameter on Narrow-Base Rim

WIDE BASE MEANS

- **Greater load capacity at high and low speeds**
- **Better cushioning of loads and equipment**

General's exclusive wide-base rim makes the big difference. Heavier loads move faster, easier. Fragile cargoes and delicate equipment roll smoothly ...breakage is minimized. That's why industries everywhere are adopting wide-base Generals as standard equipment. Investigate today. You'll find General Industrial Pneumatics do a better job on any mobile equipment where small tires and wheels are used.



Available in complete assemblies of tire, tube and rim or tire only

O. D. SIZES 8 INCHES TO 22 INCHES

Write Today New catalog shows how to save time, labor, money with General Industrial Pneumatics. Dept. 6, The General Tire & Rubber Co., Akron, Ohio.

THE GENERAL TIRE & RUBBER CO.
AKRON, OHIO

The GENERAL TIRE

WOULD YOU USE CAST IRON FOR EVERY FERROUS METAL NEED?

Certainly Not!

DO YOU USE A SIMPLE COPPER-TIN ALLOY FOR YOUR SELF-LUBRICATING BEARINGS?

If you do, consider these FACTS.

Neveroil Bearing Company makes many a simple all purpose bearing of 90% copper and 10% tin, with a porosity of 18-22%. However, we have found that this alloy, while comparable to cast iron, now meets fewer of industries' needs.

Therefore, we have at your disposal a large number of alloys, and a wide variety of densities and hardnesses, to meet your particular requirements. You can have greater bearing life when these factors are applied.

In addition to our metal line, we make impregnated maple bearings, which are unsurpassed on certain speeds and loads, together with the lowest self-lubricating bearing prices today.

We are backed by 45 years' experience in the self-lubricating bearing business.

We are backed by a new testing laboratory and able engineers, who can determine how your bearing will run, by actual life tests. We will furnish special data to support our findings. Check these with competitive products.

Your bearings are the most important part of your product. Give them all the engineering effort possible.

NEVEROIL BEARING COMPANY

Factory
32 Foundry Street
Wakefield, Mass.

Sales Offices
Chicago, Detroit,
Cleveland, Greenville, S. C.
Griffin, Ga.,
Los Angeles, Calif.

HANSEN COUPLINGS GIVE YOU 2 Big Advantages

1 QUICK CONNECTION AND DISCONNECTION

2 INSTANT AUTOMATIC FLOW OR SHUT-OFF

THESE FEATURES engineered into **HANSEN** couplings save users both time and money.

Any fluid system carrying gases, liquids, or grease can be improved by the installation of these quick-connective, automatic shut-off couplings. Slight movement of the sleeve releases the plug, and flow instantly stops. Insertion of the plug opens the line to flow... immediately... automatically.

Three types of couplings offer valve in socket, valves in socket and plug, or without valves for straight-through flow. Engineered for specific types of service, including air, oxygen, grease, acetylene, oil, hydraulic fluid, gases, or solvents.

Ask for the new catalog of our industrial line, with engineering data, or for specific information regarding the adaptation of **HANSEN** couplings to your product.

REPRESENTATIVES

New England States: Pearse-Pearson Co., West Hartford, Connecticut, Boston, Massachusetts
Atlantic, Gulf States: B-R Engineering Co., Baltimore, Md.
Northern Ohio: F. & W. Ursem Company, Cleveland, Ohio
Southern Ohio, W. Va., Northeastern Ky.: Steinhagen Airline Products, Dayton, O.
Tennessee, Arkansas, Kentucky: Ralph A. Hiller Co., Nashville, Tennessee
Michigan: William H. Nash Company, Detroit, Michigan
Indiana, Wisconsin: Neff Engineering Company, Ft. Wayne, Indiana, Milwaukee, Wisconsin
Northern Illinois, Eastern Iowa: Walter Norris Engineering Company, Chicago, Illinois
Central Midwestern States: Sturgis Equipment Co., St. Louis, Missouri
North Midwestern States: Hanscome-Rogness Company, Minneapolis, Minn.
Texas, Oklahoma: C. C. Brownfield, Dallas, Texas
Colorado, New Mexico, Utah, Wyoming: E. C. Wild Co., Denver, Colorado
Northern Calif., Nevada: R. J. Gentles, San Francisco, California
Arizona, S. California: Chester Paul Co., Glendale, California
Idaho, Oregon, Washington: Jack J. Kolberg Company, Seattle, Washington

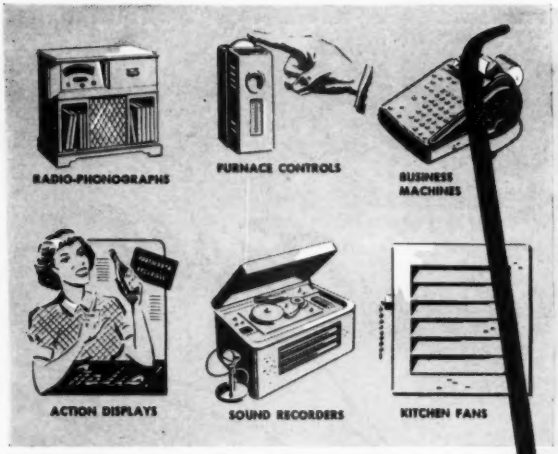
IN CANADA

Province of Ontario: John Best Associates, Toronto, Ontario
Quebec & Maritime Provinces: Cowper Company Ltd., Montreal, Quebec

QUICK CONNECTIVE FLUID LINE COUPLINGS . . .

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 11, OHIO



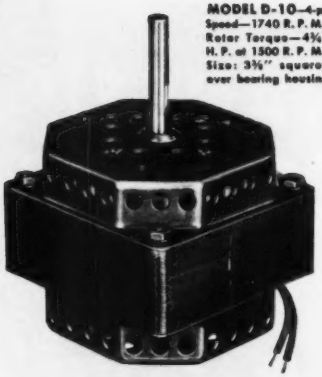
WHEREVER YOU NEED

Smooth Power

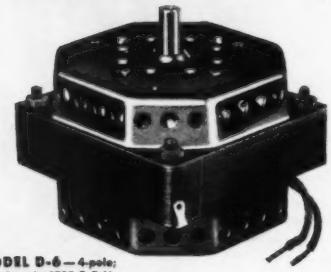
Split-second pickup to full speed . . . dependable quiet operation . . . trouble-free long life . . . these are but a few of the reasons why it will pay you to choose from the GI line of *Smooth Power* small motors for quantity requirements.

Long recognized for their superior quality and performance in phonograph and radio-phonograph applications, these two- and four-pole, shaded pole motors are compact, light in weight, and surprisingly low in cost. They are available for either clockwise or counter-clockwise rotation, and with design modifications available where quantities warrant production line changes.

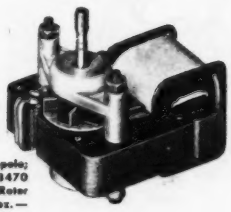
For additional information, blueprints or quantity price quotations, write *today* to:



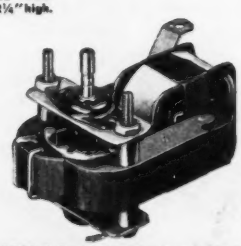
MODEL D-10—4-pole; Free Speed—1740 R. P. M.; Locked Rotor Torque—4¾ in. oz.; H. P. at 1500 R. P. M.—1/70; Size: 3½" square x 3½" over bearing housings.



MODEL D-6—4-pole; Free Speed—1725 R.P.M. Locked Rotor Torque—2¾ in. oz.; H. P. at 1400 R. P. M. — 1/140; Size: 3½" square x 2½" over bearing housings.



MODEL A-5—2-pole; Free Speed—3470 R. P .M.; Locked Rotor Torque—1.2 in. oz.—H. P. at 2800 R. P. M.—1/250; Size 2½" wide x3½"longx2¼"high.



MODEL C-5—2-pole; Free Speed—3370 R. P. M.; Locked Rotor Torque—0.9 in. oz.—H. P. at 2600 R. P. M. — 1/300; Size 2" wide x 3½" long x 2⅞" high.

The GENERAL INDUSTRIES Co.

DEPT. D • ELYRIA, OHIO

SOUR ON IT!

Machining heavy metal castings hogged the profits of a dictating machine manufacturer. Competition was forcing him to a lightweight model. He knew magnesium was light and strong, but was sour on it. Then he took his problems to Aluminum Company of America, light metal headquarters. He learned simple shop practices make handling magnesium no problem.* He found that fellow manufacturers every month are using over a million pounds of magnesium. He learned magnesium castings machine fast and have a high strength-weight ratio. He got books on designing and fabricating magnesium, plus all the technical aid he needed. Now, he buys magnesium sand and permanent mold castings from American Magnesium Corporation and gets prompt delivery. Machining and handling costs dropped, profits soared. His new lightweight model squelches competition.

*No change in insurance rates.

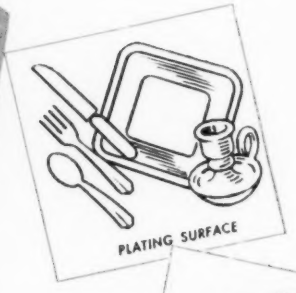
These two, free books on magnesium and our broad technical experience can help your products, too. Write Aluminum Company of America, sales agent for American Magnesium Products, 1702 Gulf Building, Pittsburgh 19, Pennsylvania.

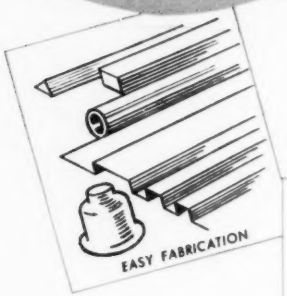
MAGNESIUM MAZLO PRODUCTS

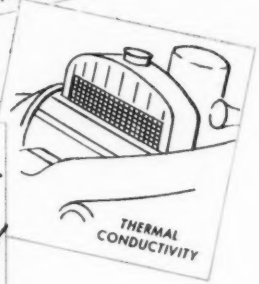
AMERICAN MAGNESIUM CORPORATION

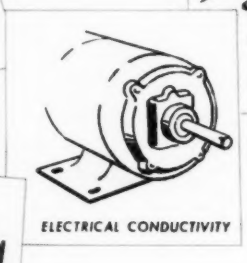
SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

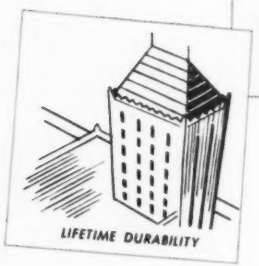
Design WITH THESE COST-CUTTING ADVANTAGES OF HUSSEY COPPER *and* BRASS

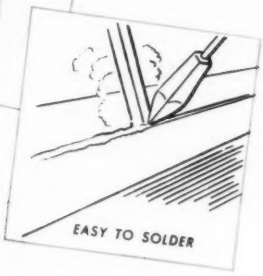












Hussey Copper and Brass give you every advantage of easy bending and forming, versatile fabrication and ready adaptability to a wide diversity of applications. Whether it is low cost fabricating, durability, lifetime beauty, corrosion resistance or conductivity you require of the metal in your product—Hussey Copper or Brass gives you a plus value. Warehouses in major industry centers assure you a prompt supply.

SHEET • STRIP • COILS • FABRICATED PRODUCTS
Rods • Wire • Tubing • Nails

C. G. HUSSEY & CO.
(Division of Copper Range Co.)
ROLLING MILLS AND GENERAL OFFICES • PITTSBURGH, PA.
Hussey warehouses carry stocks of Copper and Brass Products for prompt shipment.

Call

Your NEAREST WAREHOUSE

• PITTSBURGH
2850 Second Ave. - - - - - GRant 3650
• ST. LOUIS
1620 Delmar Blvd. - - - - CEntral 9192
• CINCINNATI
424 Commercial Square - - - MAin 2832
• NEW YORK
140 Sixth Ave. - - - - - CAnal 6-6326
• PHILADELPHIA
1632 Fairmount Ave. - - FRemont 7-7370
• CHICAGO
3900 N. Elston Ave. - - COrnelia 7-2234
• CLEVELAND
5318 St. Clair Ave. - - - - UTah 1-3838

HURRICANE!

How violent? Where heading? How fast?

Hurricane warnings that save so many lives on land and sea—where do they come from? From seismograph recorders, perhaps better known for their earthquake-locating power. These sensitive instruments, stationed all over the country and on Atlantic and Pacific island outposts, locate and plot the minute-by-minute movement of violent atmospheric disturbances . . . and pen the vital data on tape.

The heart of each of these life-savers is a Telechron Timing Motor . . . *instantly, constantly synchronous.* No other motor could be trusted with the tremendous responsibility of feeding facts to the scientists who dedicate their time and talent to this most important work.

Have you a timing problem?

What variable factors do you want to control or record with split-second accuracy? The chances are that the correct application of a standard Telechron Motor is the answer to your problem. A Telechron Application Engineer can quickly tell you. Consult him early in your planning and save time and trouble. In the meanwhile, fill in and mail the coupon below today for up-to-the-minute facts about Telechron Synchronous Motors.

Telechron®

ALL TELECHRON TIMING MOTORS ARE

INSTANTLY . . . CONSTANTLY SYNCHRONOUS

Telechron Inc. A General Electric Affiliate
10 Union Street
Ashland, Massachusetts

Please send me information on Telechron Synchronous Motors (maximum torque: 2 pound inches at 1 rpm). My possible application is:

- ☐ Instruments
- ☐ Timers
- ☐ Electric Appliances
- ☐ Cost Recorders
- ☐ Advertising, display items
- ☐ Juke Boxes
- ☐ Air Cond. & Heat'g Controls
- ☐ Communications Equipment

Other (please fill in)

- ☐ _____
- ☐ _____
- ☐ _____

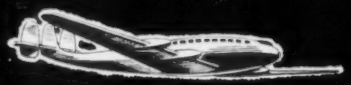
NAME_____

COMPANY_____

ADDRESS_____

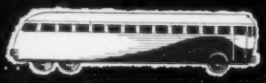
CITY_____ ZONE_____ STATE_____

Plane.....



Train.....

Bus.....



Truck.....

or

Car.....

All transportation GAINS wherever

Superior Stainless

is used!

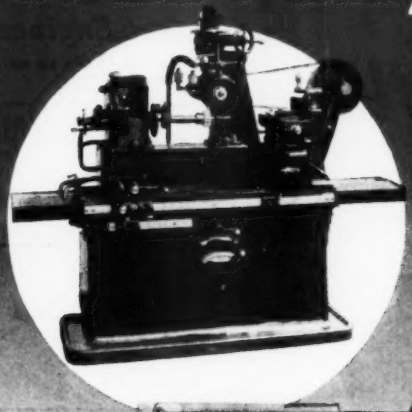
Superior Stainless Strip Steel has the strength and rigidity that are primary needs in transportation applications. Superior Stainless has the wear-proof, mar-resisting toughness that keeps maintenance low. Superior Stainless has the solid-clear-through brightness that laughs at time and weather! • What grades, finishes, dimensions and coil lengths do you require?

Superior Steel

CORPORATION

CARNEGIE, PENNSYLVANIA

We were Proud of this GEARGRIND 30 Years Ago!



At that time it represented ten years of progress in the art of Formed Wheel Grinding, whereby gears and splines were ground after hardening by means of an accurately formed grinding wheel. The contour of the grinding wheel was maintained by frequent dressing, using a special Geargrind wheel trimmer.

TYPE
GG-10 x 48A

BUT PRESENT MODELS EARN More Money for You!

About the only resemblance between today's GEARGRIND and its predecessors is the principle involved.

On the GG-10 x 48A shown above tooth spacing is controlled by a precision ground master index plate. The work reciprocates past the grinding wheel on a short stroke—just long enough to clear the wheel—and at each reversal point the grinding wheel feeds down. After grinding on one tooth space until a "rough size" is reached, the work is automatically indexed and the next tooth space is ground.

After a predetermined number of teeth have been ground the dresser automatically moves into position to true the grinding wheel. Once the roughing is complete the work is finish ground in the conventional manner, indexing automatically from tooth to tooth.

This method of grinding is 3 to 4 times faster than by any previous machine of comparable capacity, and the many automatic features permit one man to operate more than one machine.

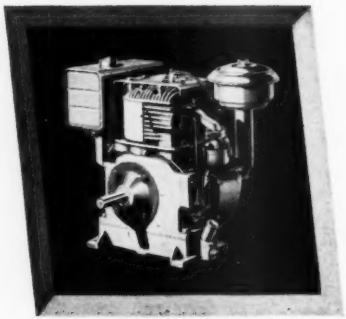
FEATURES

- Automatic grinding wheel feed
- Automatic wheel feed for truing
- Automatically cushioned trim position
- Automatic lubrication of ways
- Double column support for grinding wheel head
- Axial grinding wheel spindle adjustment
- High work table speeds
- Control panel with interlocked safety features and highly accessible push button and other control
- Index head spindle mounted on tapered roller bearings

The GEAR GRINDING MACHINE COMPANY
DETROIT 11, MICH. U.S.A.

Write for Information Today!

If You Have a Gasoline Engine Power Problem



"Preferred" Air-Cooled Power

Briggs & Stratton offers you advantages no other manufacturer of single cylinder, air-cooled engines in the world can match.

These are the engineering skill, knowledge, and counsel as well as the unequalled performance that come from *30 years of experience* — plus the advantages of a world-wide service organization. That extra experience, that extra skill assures you the best in design, materials, workmanship, and precision production.

This experience is yours for the asking. Our engineers are ready to counsel with you to help solve your gasoline engine power problems.

BRIGGS & STRATTON CORP., Milwaukee 1, Wis., U. S. A.

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES
Preferred Power FOR INDUSTRIAL CONSTRUCTION RAILROAD AND FARM EQUIPMENT

RECENT BOOKS *for the* Product Engineer

See them, 10 days FREE

PROCESS ENGINEERING

By William H. Schutt
Wm. H. Schutt Associates, Detroit

1. This book shows you how to establish the proper sequence of operations and exact labor cost *directly from the blueprint* . . . how to determine the quantity and cost of materials to be used . . . how to plan efficient tools, dies, jigs, and fixtures for economical production. Here's a money-saving book that eliminates guesswork in cost-estimating.

308 pages, $4.00

MACHINE DESIGN

By Paul H. Black
Prof. of Machine Design, Cornell University

2. Here is a complete discussion of each phase of machine designing, from the adaptability and selection of materials for the various machining processes to the elimination of vibration . . . practical aids, hints and suggestions on everything from good form in making machine-design computations to detachable machine fastenings.

Includes Full Treatment of Stress Concentration

Making the book unique is the complete treatment it gives to stress concentration—its applicability—seriousness—mitigation—determination—and design application.

334 pages $4.00

Engineering Applications of
FLUID MECHANICS

By J. C. Hunsaker,
Dept. of Aeronautical Eng., M.I.T.
and B. G. Rightmire,
Dept. of Mech. Eng., M.I.T.

3. Here is an unusually detailed book applying the important basic principles of fluid mechanics to everyday problems. It makes use of advanced, improved methods to analyze problems and equipment involved in fluid flow . . . covers hydraulic circuits and servomechanisms. Here are diagrams, formulas and equations necessary for a complete understanding of fluid mechanics . . . presented in easy-to-follow form for a quick understanding of the principles involved.

487 pages $5.00

10 DAYS' FREE EXAMINATION

McGraw-Hill Book Co., Inc., 330 W. 42d St., NYC 18

Send me book(s) corresponding to the numbers encircled below for 10 days' examination on approval. In 10 days I will remit the price of the book(s) I wish to keep, plus a few cents delivery charge, and return unwanted books postpaid.*

1 2 3

Name .....
Address .....
City ..... Zone..... State.....
Company .....
Position PE-2-49

* SAVE! We pay mailing costs if you send cash with this coupon. Same return privilege.

108 A's ON HIS REPORT CARD

HE HAS TO PASS WITH HONORS BEFORE HE CAN GO TO WORK FOR YOU

THE flanged copper-lead sleeve bearing shown above was graduated from a rigid "school" conducted by Federal-Mogul's Quality Control group.

In the process of 28 manufacturing operations, this bearing received a series of precise setup and inspection measurement checks—84 in all! Twenty-four additional tests included analyses, temperature controls, special and visual examinations.

Where "A" meant 100%, this bearing passed 108 times! Otherwise, it never would have left the factory.

The same vigilant care is exercised throughout all six Federal-Mogul plants, in the manufacture of *every* bearing. We are equipped for large or small runs, to your specifications. Consult our engineers on *your* bearing requirements.

HIGH SPEED, high temperature, automotive type bearings available in many combinations.

HEAVY LOAD for big Diesels, power plants, etc.—bearings up to 27½" O.D., steel and bronze back.

SPEED & LOAD bearings for pumps, compressors, industrial electric motors and similar uses.

BRONZE PARTS in many shapes, sizes; thrust washers, bushings; for many types of applications.

Power goes to work smoothly through

FEDERAL-MOGUL

FEDERAL-MOGUL CORPORATION — FEDERAL Mogul Silent SLEEVE BEARINGS — **11043 SHOEMAKER, DETROIT 13, MICH.**

A Big Step Forward!

ALL-METAL
CHROMALOX
Electric
RADIANT HEATERS

A New Infrared Heat Source

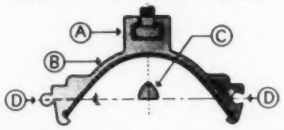
Now—You can use infrared heat in many applications where it has not been entirely practical before. That's because the new, all-metal CHROMALOX Radiant Heaters withstand shock, vibration, dust and moisture . . . they provide glareless infrared radiation in wave lengths which are absorbed almost equally well by all colors, textures and surfaces . . . they operate efficiently in high and low ambient temperatures.

FLEXIBLE IN APPLICATION—CHROMALOX Radiant Heaters are used for infrared drying, preheating, baking, curing, mass-heating, skin-drying, dehydrating and similar applications. Tongued-and-grooved sides facilitate fabrication of heater sections into various working patterns such as banks, tunnels, ovens, etc.

HIGH IN EFFICIENCY—The heat source is an efficient Inconel-sheathed CHROMALOX Tubular element which operates at temperatures of 1000° to 1400° F. It produces uniform and even heat without hot-spots and with a negligible amount of incandescent light. "Alzaked" aluminum reflector sheet gives maximum radiation.

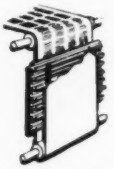
GLASSLESS, ALL-METAL CONSTRUCTION—Extruded aluminum body and shock-proof heating element withstand rough usage; dangers of glass breakage are eliminated. Compact size—4" depth with lengths of 25", 31" and 47". Units come complete with adjustable mounting bolts, ready to install.

QUICK, LOW COST INSTALLATION
EFFICIENT, DEPENDABLE SERVICE

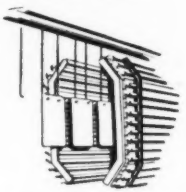


A. Two adjustable captive-bolts per section permit quick and easy mounting into desired position.
B. Extruded aluminum body is equipped with a highly polished, non-oxidizing parabolic reflector for maximum reflectivity.
C. Heat source is high temperature Chromalox triangular-shaped element located to give efficient direct and reflected radiation.
D. Units can be quickly interlocked lengthwise to form straight lines and circular or oval banks of any desired width.

TYPICAL APPLICATIONS:



Single-banks of Chromalox Heaters, mounted in line, bring the efficiency of infrared heat to applications where it was not practical heretofore because of space limitations.



Easily formed, double-banks of Chromalox Radiant Heaters are ideal for line-production. Infrared rays are radiated directly and uniformly on materials being processed.

Sections may be interlocked to form tunnels over conveyor belts; units operate with equal efficiency from all angles. Their glassless construction permits their use in processes and assembly lines which formerly avoided infrared heat because of the hazards of open flames or glass breakage and contamination.

CHROMALOX

Electric Heat for Modern Industry

EDWIN L. WIEGAND CO. 7535 THOMAS BLVD., PITTSBURGH 8, PA.

Write for Free Bulletin CS-603

It contains complete information and specifications on the all-metal Chromalox Electric Radiant Heaters and shows how you can use these units in your present or projected infrared applications.

1C-40

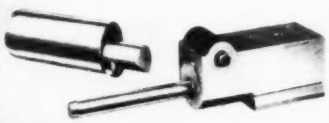
Production gaging with External Comparator No. 951 and Amplifier 950.

with this UNIQUE *Electronic* MEASURING EQUIPMENT

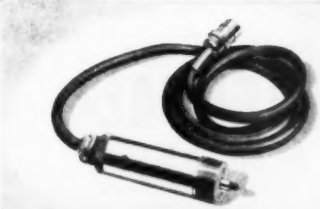
ADVANCED design and construction features make this Brown & Sharpe Measuring Equipment unusually fast, accurate and dependable. Its separate amplifier, for example, completely isolates heat-producing elements . . . thus prevents temperature drift in gaging units. Its true linear response permits accurate setting for the entire scale with only one master block. A single amplifier may be used to serve several separate testing instruments. Line voltage fluctuations within the range of 105 to 125 volts do not affect readings.

These and other advantages make precision gaging on a mass-production basis both practical and economical for any plant or laboratory. Get all the facts about this unique Electronic Measuring Equipment. Write Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

We urge buying through the Distributor



Speedy Internal Gaging from ½" to 2" is provided by Internal Comparator Attachment No. 952. For use with External Comparator No. 951.



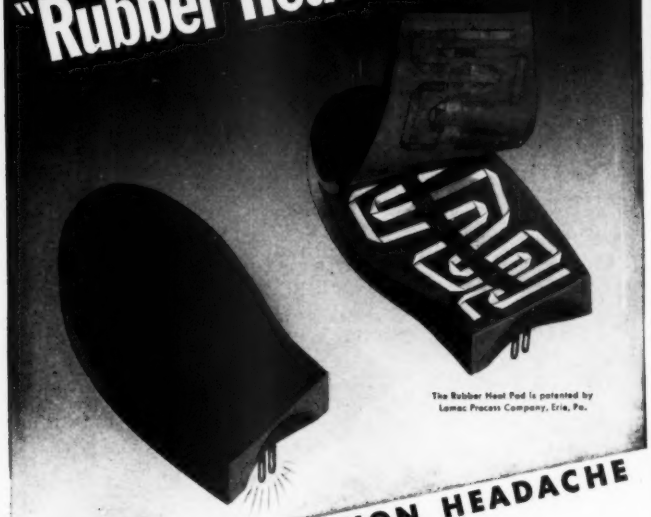
Extremely Accurate Gaging (.0001" to .00001") in stands, jigs and fixtures is offered by Gage Head Cartridge No. 953. Plugs in directly to Amplifier No. 950.

Visual Indication of work conditions show quickly on Signal Light Attachment No. 958. For use with Amplifier No. 950. Easily attached.

BROWN & SHARPE

THIS

"Rubber Heat Pad"...



The Rubber Heat Pad is patented by Lamac Process Company, Erie, Pa.

CURED A PRODUCTION HEADACHE

This electrically heated rubber pad has reduced the time required for re-soling shoes in the famous Lamac Press by as much as 75%.

Continental made this improvement possible because it was able to develop a rubber compound that would withstand the intense heat generated by the electrical heating element. Continental also solved the equally difficult problem of positioning this heating element so that it would not shift and "short" itself when the pad was molded.

The success of this development is another example of the specialized assistance in rubber which Continental offers to design and production engineers.

If You Have Rubber Problems, Send for This Helpful Booklet.
Three minutes' reading time will give you a new conception of the assistance you can gain by consulting specialists in rubber. Just ask your secretary to write for a copy today.

Rubber by

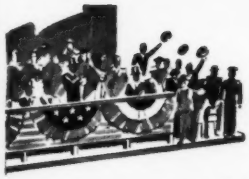
CR

CONTINENTAL RUBBER WORKS

1982 LIBERTY BOULEVARD • ERIE, PENNSYLVANIA

BRANCHES

Baltimore, Md.	Dayton, Ohio	Los Angeles, Calif.	Pittsburgh, Pa.
Boston, Mass.	Detroit, Mich.	Lutz, Fla.	Richmond, Va.
Buffalo, N. Y.	Hartford, Conn.	Memphis, Tenn.	Rochester, N. Y.
Chicago, Ill.	Indianapolis, Ind.	Milwaukee, Wis.	St. Louis, Mo.
Cincinnati, Ohio	Kansas City, Mo.	New York, N. Y.	San Francisco, Calif.
Cleveland, Ohio	Lancaster, S. C.	Philadelphia, Pa.	Syracuse, N. Y.



P—15A

HERE'S A *Parade*

YOU WON'T WANT TO MISS...

Everybody loves a parade but here's one that's particularly interesting to YOU because it's packed with "pocket-book" appeal. It's a never-ending parade of products and services designed to help you do *your* job better, quicker and cheaper. You're in the "reviewing stand" for this parade because it comes to you in the advertising pages of every issue of this magazine. Alert manufacturers use these advertising pages to get the *news* about their products and services to *you*... quickly and effectively. To be well-informed about the latest developments in *your* industry... and to stay well-informed... *read all the ads too.*

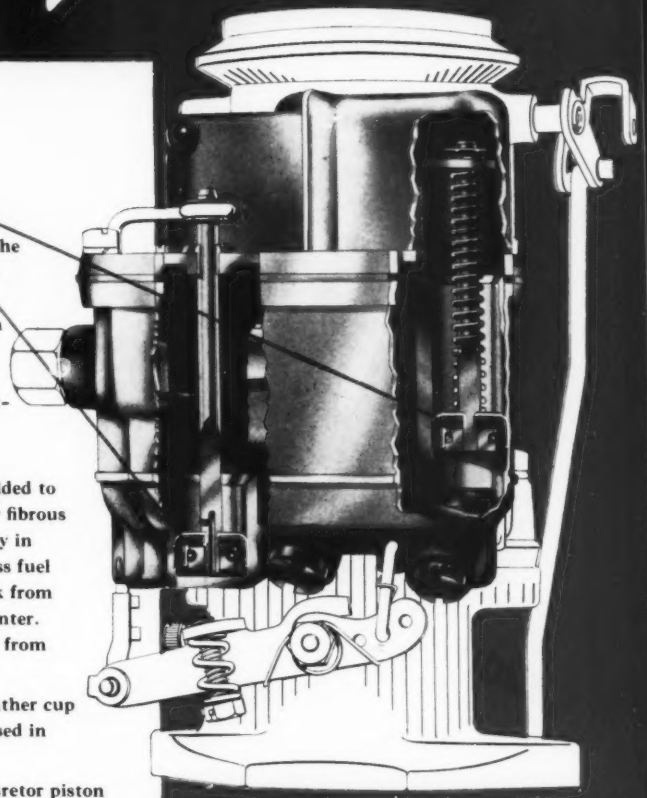
McGRAW-HILL PUBLICATIONS

HEADQUARTERS FOR INDUSTRIAL INFORMATION

• IN ENGINEERING, AS IN DRIVING

it's little things that count

Like that little squirt of gasoline, when you want quick starting and fast pick-up. And the little piston pump packing which helps you get it. In Stromberg carburetors (made by Bendix Aviation Corp.), special care is taken to assure complete dependability of *every* component part. In model BXVD-3, for instance, two leather cup packings are used—one on the dash pot piston and the other on the pump piston.



These cup packings must be accurately molded to size; they must *stay* wrinkle-free; and their fibrous texture must have that tightness found only in prime calfskin. These cups must not by-pass fuel or become logged; they must neither shrink from heat nor freeze to their cylinder walls in winter. Their leather tannage must not deteriorate from contact with oils or gasoline.

Non-deteriorating *chrome* tanned Sirvis leather cup packings, made by Chicago Rawhide, are used in thousands of Stromberg carburetors.

Chicago Rawhide engineered the first carburetor piston pump packing to deliver satisfactory performance. Today, they are used in many leading makes. Because of constant research and product development, precise laboratory control, highest standards of leather quality, and exceptional care in every phase of production, Chicago Rawhide's Sirvis leather piston pump packings continue to be the most dependable.

CHICAGO RAWHIDE MANUFACTURING CO.
1299 Elston Avenue Chicago 22, Illinois

for assured performance

in your leather applications—whether in connection with oils, grease, water, or air, under high, low or static pressures—specify SIRVIS. Your inquiries will be promptly answered.

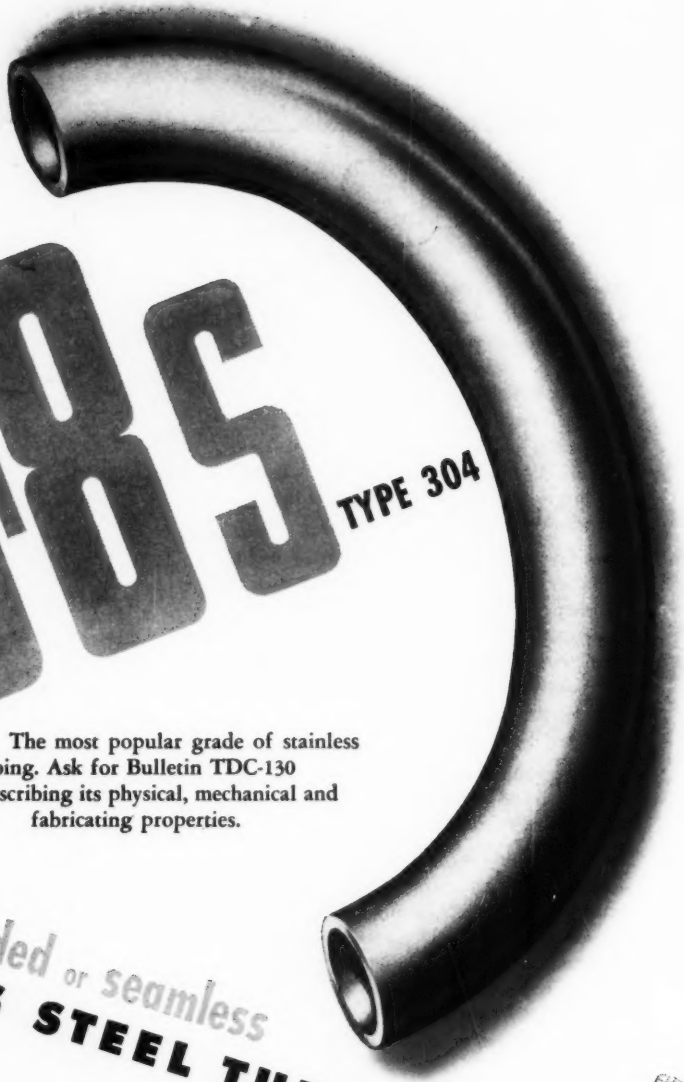
SIRVIS
MECHANICAL LEATHERS

OUR 70th YEAR OF INDUSTRIAL SERVICE

OTHER C•R PRODUCTS
PERFECT Oil Seals
SIRVENE Synthetic Rubber

1949

Answers MOST corrosion problems



CROLOY 18-8S TYPE 304

The most popular grade of stainless steel tubing. Ask for Bulletin TDC-130 describing its physical, mechanical and fabricating properties.

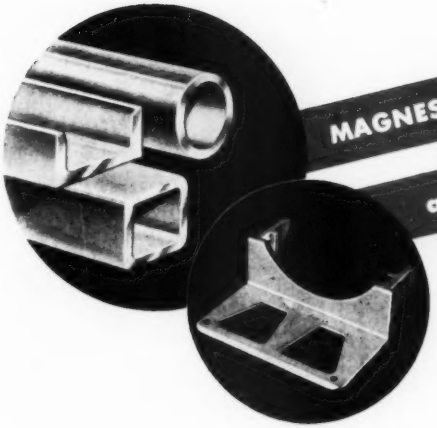
welded or seamless
STAINLESS STEEL TUBING

THE BABCOCK & WILCOX TUBE COMPANY
General Offices: Beaver Falls, Pa.
Plants: Beaver Falls, Pa. and Alliance, Ohio

BABCOCK & WILCOX SEAMLESS & WELDED TUBES

A full range of Stainless, Alloy and Carbon Steel Tubing for All Pressure and Mechanical Applications.

TA 14655



MAGNESIUM EXTRUSIONS . . .

and SAND CASTINGS . . .

unite for fabrication economy . . .

They cut dead weight...

and costs too!

Here's an outstanding example of how magnesium combines increased lightness and strength with sound manufacturing economies.

Versatile extrusions and sturdy sand castings worked together to cut the weight of this truck by 50%. Its stressed aircraft type construction carries loads up to 600 pounds—withstands the highest torsional strain and twist. Yet, design, fabricating, and assembly were greatly simplified through the use of magnesium. Special extruded sections form the frame, and the "nose-piece" is a single sand casting, increasing over-all truck strength by 30%. Bolted or riveted sections rather than welded sections speed dismantling and replacement of parts—reduce breaking—keep maintenance costs down.

Add to these important advantages of magnesium its ready availability and competitive price. The total tells the story—it pays to use magnesium.

DOW

DOWMETAL

Magnesium IN MANY APPLICATIONS Pays

Write for this revealing free book "How Magnesium Pays." It's filled with actual case studies of how manufacturers of a wide range of products have found that magnesium pays.

Send me the study MP-49-23 "How Magnesium Pays"

NAME _____

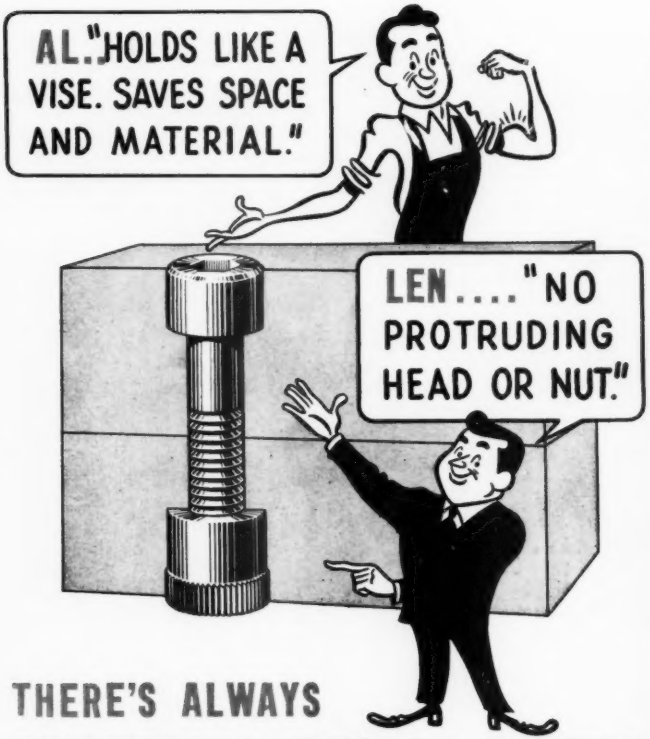
TITLE _____

FIRM _____

ADDRESS _____

MAGNESIUM DIVISION • THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle • Dow Chemical of Canada, Limited, Toronto, Canada



THERE'S ALWAYS SOMETHING NEW IN ALLENS

The Allenut* is the precision counterpart of Allen Hex-Socket Cap screws. A "ready-made" threaded hole, one end tapped to a Class 3 fit, the opposite end with a double hex socket for wrenching. Greater holding power, easier assembly, more compact design, all are made possible by the new Allenut*, now available from No. 4 to 1", NC or NF threads. Here's another instance to prove that the Allen dealer is the man to see first for the answer to a precision fastening problem. For technical information, write the factory direct.

Popular sizes of Allen Hex-Socket Set Screws and socket head cap screws now standard and available in stainless steel from distributors' stock. New methods, new alloys, new designs are constantly being investigated, and the best put to use to make every Allen socket screw, dowel pin and pipe plug the best money can buy.

*Patent applied for

WARNING

Allen-TYPE screws aren't necessarily Allen-MADE. Be sure to get genuine ALLENS in the black and silver box

SOLD ONLY THROUGH LEADING DISTRIBUTORS

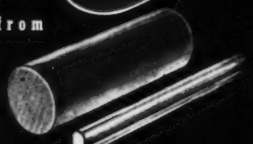
ALLEN MFG. CO. — ALLEN HEAD

Hartford 2, Connecticut, U.S.A.

NEW YORK, CLEVELAND, DETROIT, CHICAGO, LOS ANGELES

Fabricated ALUMINUM EXTRUSIONS Ready for Assembly

from



BILLET to **EXTRUDED SHAPE**

to

FABRICATED SHAPE

then

BUFFED and **ANODIZED**

DRAWER PULL is furnished completely fabricated and finished-ready for your assembly

SEND YOUR INQUIRIES...

Light Metals Corp. has facilities for extruding, fabricating and finishing to your specifications. Send us a part print or even a rough sketch and we will furnish recommendations and cost estimates.

"Shapes are our Business"

LIGHT METALS CORP.

1215 MONROE, N. W., GRAND RAPIDS, MICH.

FREE! THE MOST COMPLETE V-BELT DRIVE HANDBOOK EVER PUBLISHED

ACTUAL SIZE

384 Pages. Millions of Drive Combinations... Completely Indexed... As easy to use as the phone book

You'll find this handbook a complete encyclopedia on V-Belt Drives. Everything you want to know... design information, engineering data, drive tables and combinations... all have been carefully worked out to relieve you of any calculations, engineering and complicated formulas. You'll save countless hours of time and mental work.

Everything is completely indexed for quick reference.

- Comprehensive V-to-V and V-Flat Drive data.
- Speed-Up V-Belt Drives for standard motor speeds.
- Speed-Up and Speed-Reduction Drives for Gas and Diesels.
- Complete data on V-Belt Horsepower ratings and belt speeds.
- How to design fixed center, quarter turn drives, etc.
- Complete data on pulleys, V and Flat.

Every Design Engineer should have this book in his library. Let us send you your personal copy today. No obligation. Simply write, *Dayton Rubber Co., Dayton 1, Ohio.*

V-BELT DRIVES for Standard Motor Speeds. How to select V-Belt Drives. Service Factors. Complete Selection Tables for all Cross-Section Belts.

V-FLAT DRIVES. How to Select. Characteristics and Advantages. Service Factors. Selection Tables.

SUPPLEMENTARY DRIVE TABLES. Speed-Up and Speed Reduction V-Belt Drives for Standard Motor Speeds. Gas and Diesel Engines, Jackshafts, etc.

ENGINEERING DATA — Special Drives. Service Factor. H. p. Ratings. Quarter Turn Drives. Fixed Center Drives. Installation and Maintenance Information.

PRICES AND DIMENSIONS. V-Groove Pulleys. Flat Pulleys. Thorobred V-Belts. Oil, Heat and Static V-Belts.

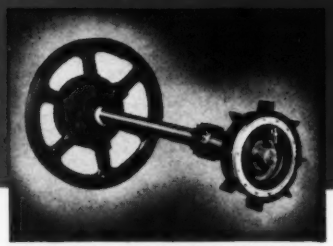
INTERCHANGEABILITY LISTS. Complete Lists showing Interchangeability for Equivalent Sizes.

WRITE TODAY **Dayton Rubber**

FAWICK-EQUIPPED MACHINES

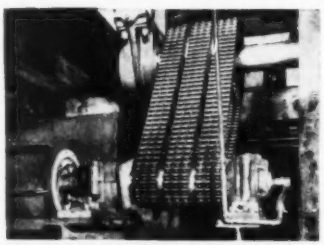
do More Work at Less Cost

Fawick Air-Ring Clutch or Brake Type E



Fawick Airflex Clutch and Fawick Air-Ring brake conversion for Toledo Model 96C Press.

Fawick Air-Ring Clutches on Plated Strip Rewinder at Thomas Steel Co., Warren, Ohio.



Triple Fawick Air-Ring Clutch on Head Rig Drive to Sumner 9' Head Mill at Universal Box Co., Ltd.

Time-wasting clutch adjustment down time is practically eliminated on Fawick-equipped machines. The moving parts of this Fawick Clutch—the rubber-and-fabric pneumatic tube and the friction shoe assemblies—adjust automatically and compensate for wear.

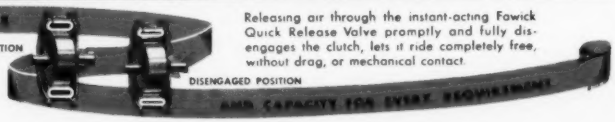
The smooth engagement action of this Fawick Clutch eliminates sudden shock loads which damage machinery. Controlled torque starting can be obtained with a simple modulating air valve. This type Fawick Clutch is ideally suited to continuous slip applications.

For specific recommendations for your machines, write to our Engineering Department today. Address Dept. PE.

FAWICK Airflex CO., INC.

9919 CLINTON ROAD CLEVELAND 11, OHIO

THERE IS A FAWICK CLUTCH OF PROPER TYPE AND CAPACITY FOR EVERY REQUIREMENT

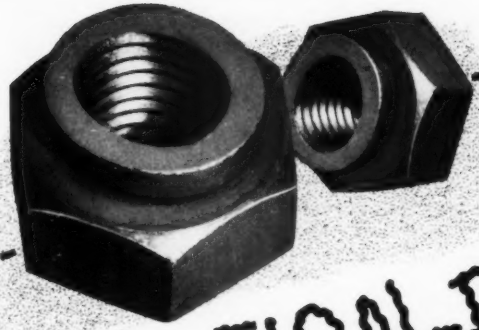


ENGAGED POSITION

Expanding under force of compressed air, the rubber-and-fabric tube smoothly engages the clutch with the precise degree of grip required by the job.

DISENGAGED POSITION

Releasing air through the instant-acting Fawick Quick Release Valve promptly and fully disengages the clutch, lets it ride completely free, without drag, or mechanical contact.



VIBRATION-PROOF!

¼" TO 2" DIAMETERS
PACKAGES OR BULK

PATENT No.
2,255,286

LAMSON LOCK NUTS

Does a product of yours have the "shakes"? Is it subjected to conditions where vibration is a major problem? If so, it will pay you to consider the use of inexpensive Lamson Lock Nuts.

These one-piece all-steel lock nuts have a heat-treated spring-grip locking collar which HOLDS the nut on the bolt under the most severe conditions of vibration. They will hold until backed off with a wrench and can be reused without loss of grip. Tests at 600°F. and -40°F. prove that neither heat nor cold materially affect their holding power. They are also unaffected by steam, oil or water.

Manufacturers of machinery, earth moving equipment, pumps, trucks and other products subjected to severe vibration have found Lamson Lock Nuts the ideal solution to their fastening problems. Write *today* for additional information.

THE LAMSON & SESSIONS COMPANY
General Offices: 1971 West 85th Street, Cleveland 2, Ohio
Plants at Cleveland and Kent, Ohio • Birmingham • Chicago

Lamson & Sessions
"One Dependable Source for All Fastener Needs"

SEMS	LOCK NUTS	NUTS	STUDS
STOVE BOLTS	LAG BOLTS	WASHERS	RIVETS
TAPPING SCREWS	ROPE CLIPS	SET SCREWS	PLOW BOLTS
"1035" CAP SCREWS	MACHINE BOLTS	CARRIAGE BOLTS	COTTER PINS

WANT MORE INFORMATION on any of these fasteners? CHECK—and CLIP this strip.

—CUT ALONG THIS LINE—

LAMSON LOCK NUTS: Economical, vibration-proof. Can be re-used repeatedly.

"1035" SET SCREWS: Cup point type, hardened, heat-treated.

COTTER PINS: Steel, Brass, Aluminum and Stainless Steel.

SPECIAL NUTS: Cone, Barrel, Oblong, Plier, Tri-Slot, Half-round, etc.

PHILLIPS AND CLUTCH HEAD: Machine Screws and Tapping Screws.

MILLED STUDS: Concentric, accurate, in a full range of sizes.

"BENT" BOLTS: Including U Bolts, Eye Bolts, Hook Bolts, etc.

WEATHER-TIGHT BOLTS: Eliminate counter-boring in wood assemblies.

PIPE PLUGS: Forged Steel, heat-treated.

The Lamson & Sessions Company
1971 W. 85th St., Cleveland 2, Ohio

NAME

POSITION

COMPANY

STREET

CITY ZONE STATE

There Go 3269 Fasteners!

Tonight's test is tough . . . Doc Smith must get through . . . he's depending on the miracle of American mass production and (unknowingly) on the 3269 fasteners that give his car strength and stamina.

Over 500 screws . . . 331 nuts . . . 400 bolts . . . hundreds of rivets . . . furnish the forces that lock automobile assemblies together.

With this responsibility that fasteners must carry, it is obvious that quality is essential. That's why Russell, Burdsall & Ward makes the huge investment it does—in wire drawing mills of its own, in wire preparation, in laboratory equipment for extensive research, in advanced designs of equipment—all of which contribute to quality control.

Fastener *quality* and production savings go hand in hand. It isn't the initial price but the cost of *using* fasteners that counts. *True Fastener Economy* lies in *saving* assembly time, *reducing* the need for plant inspection, *getting* maximum holding power per dollar of fastener cost.

True Fastener Economy contributes to the kind of production savings that puts millions of new cars in U. S. driveways every year. It is this type of contribution to major American industries that explains why—for over 104 years—RB&W has been *making strong the things that make America strong.*

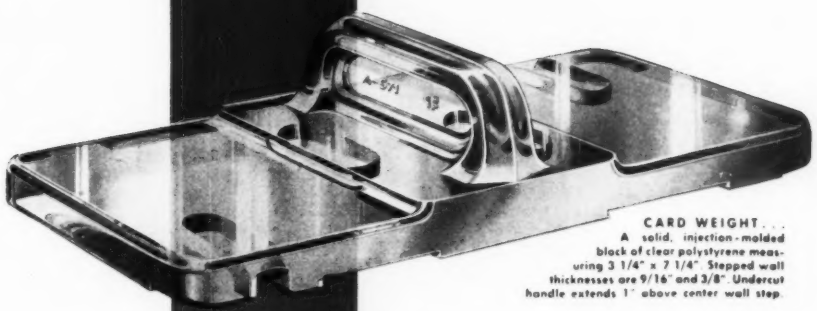
RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

RB&W

Plants at: Port Chester, N. Y., Coraopolis, Pa., Rock Falls, Ill., Los Angeles, Calif. Additional sales offices at: Philadelphia, Detroit, Chicago, Chattanooga, Oakland, Portland, Seattle. Distributors from coast to coast.

3269 Fasteners are used in 1 small American car

104 YEARS MAKING STRONG THE THINGS THAT MAKE AMERICA STRONG



CARD WEIGHT . . .
A solid, injection-molded block of clear polystyrene measuring 3 1/4" x 7 1/4". Stepped wall thicknesses are 9/16" and 3/8". Undercut handle extends 1" above center wall step.

It takes a "Steady Hand" to *hold down* this Job!

This Approved Plastic Part's Required Qualifications Also Emphasized

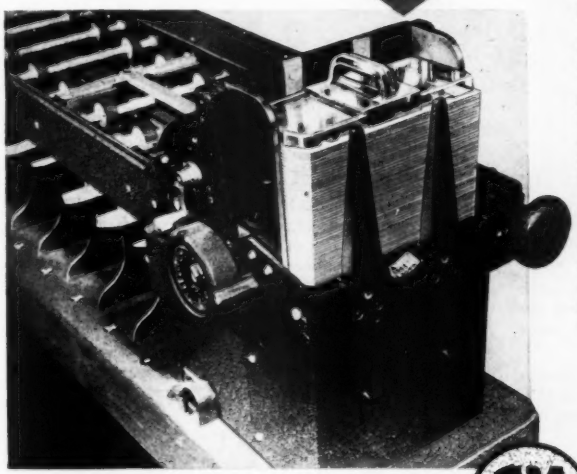
CLARITY • TOUGHNESS ECONOMY

This part is a Card Weight . . . molded of clear polystyrene. It was designed by and processed for International Business Machines Corporation, Endicott, New York.

It is used as a "steadying hand" in the hopper of an automatic card feed on a business machine.

The transparency of the selected material lends itself to viewing the stacked cards. Its toughness makes it practically unbreakable. Carefully engineered mold construction produced the handle undercuts and recesses in one operation—most economically!

This plastic part, which has so completely satisfied its end-use requirements, exemplifies the type of molding in which Consolidated excels. We are confident that our broad experience and know-how can be advantageously applied to your particular planning in plastics. Our sales engineers are ready to serve your inquiry.



Above illustration shows an IBM Electric Punched Card Sorting Machine with cards stacked for automatic sorting. Note plastic Card Weight in its steadying position on top of stack.

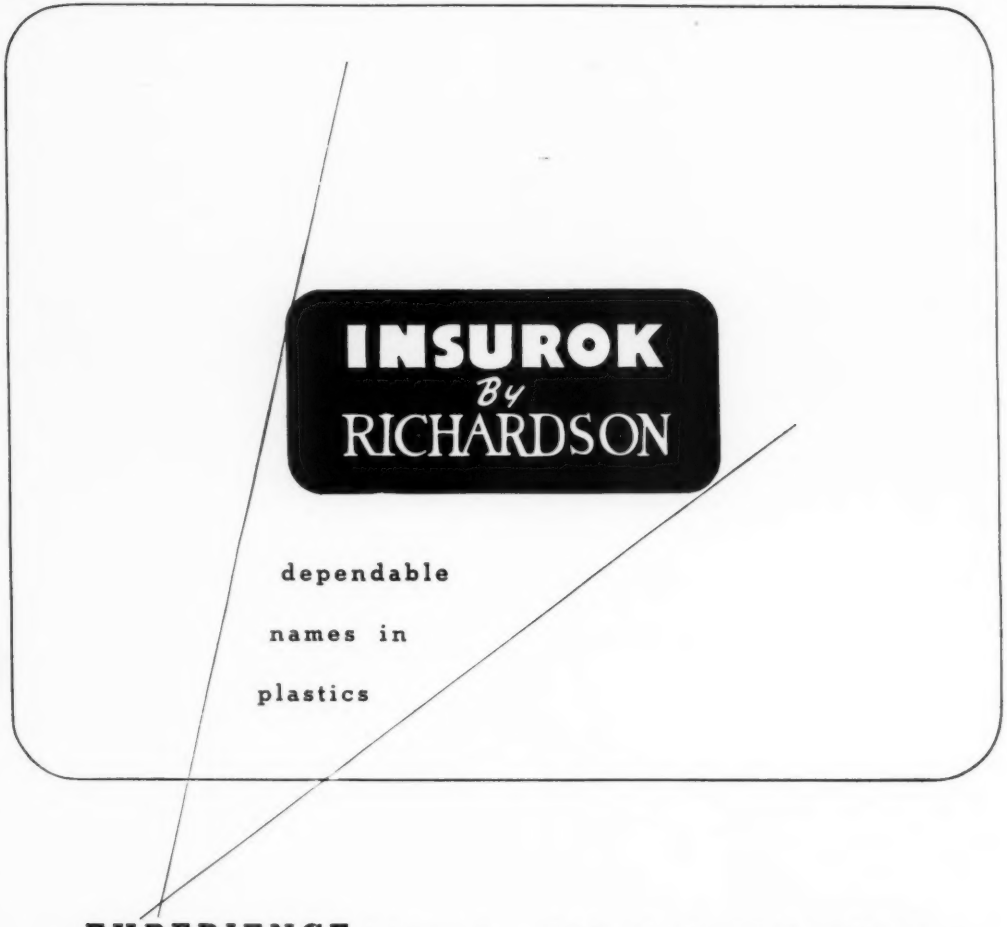
CMP

Your Blue Print in Plastic

Consolidated
MOLDED PRODUCTS *Corporation*
309 CHERRY STREET,
SCRANTON 2, PA.

Branches: NEW YORK, 1790 Broadway • CHICAGO, 549 W. Randolph St. • DETROIT, 550 Manchester Bldg. • CLEVELAND, 4614 Prospect Ave. • BRIDGEPORT, 211 State Street

PRODUCT DEVELOPMENT • MOLD DESIGN • MOLD CONSTRUCTION • PLUNGER MOLDING • TRANSFER MOLDING • INJECTION MOLDING • COMPRESSION MOLDING



EXPERIENCE is just one of the factors that make the names of INSUROK and Richardson more significant to manufacturers whose products require laminated or molded plastics. Richardson customers benefit from this experience in many ways.

(1) Richardson experience with a wide variety of plastic materials helps you select the one that accomplishes your purpose most effectively, efficiently and economically.

(2) Richardson experience in the design and production of Laminated INSUROK and Molded INSUROK products has resulted in savings to scores of manufacturers.

(3) Richardson's many proven grades of Laminated INSUROK are available in sheet, rod or tube stock or in fabricated, punched or post-formed component parts for an endless variety of applications.

(4) INSUROK plastic products and Richardson services have played an important part in the development and refinement of many products.

It might be to our mutual advantage to know how these materials and services can work for you.

INSUROK is a registered trade-mark of The Richardson Company

The RICHARDSON COMPANY

GENERAL OFFICES: LOCKLAND, OHIO FOUNDED IN 1858

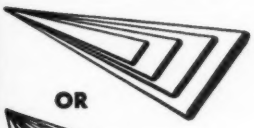
Sales Headquarters: MELROSE PARK, ILLINOIS

CLEVELAND · DETROIT · INDIANAPOLIS · MILWAUKEE · NEW BRUNSWICK, (N. J.) · NEW YORK · PHILADELPHIA · ROCHESTER · ST. LOUIS

PAGE Stainless Steel WIRE

ROUND

FLAT



OR

SHAPED

'Page for Wire—Especially Stainless'

Remember that the next time you are looking for a responsible source for stainless steel wire. Wire has always been the business of PAGE. And PAGE has been working with stainless ever since its earliest development.

Whatever problem you may have involving wire—

Get in touch with Page!

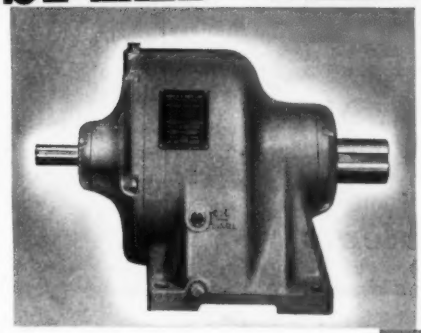
ACCO

Monessen, Pa., Atlanta, Chicago, Denver, Detroit, Los Angeles, New York, Pittsburgh, Philadelphia, Portland, San Francisco, Bridgeport, Conn.

PAGE STEEL AND WIRE DIVISION
AMERICAN CHAIN & CABLE

In Business for Your Safety

The Most Complete Line of SPEED REDUCERS



Available from Any One Source

Including the Revolutionary New

WINSMITH SPEED REDUCERS

DIFFERENTIAL UNITS

No. 31H Differential Speed Reducer

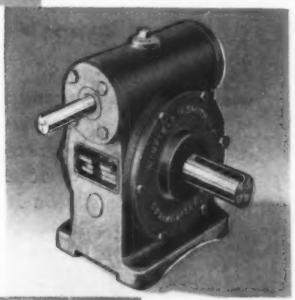
PROVIDES STILL GREATER *Economy and Efficiency*

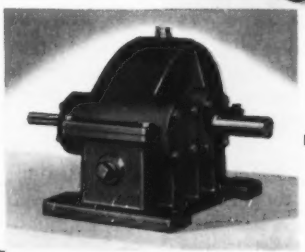
SAVES VALUABLE SPACE

Direct Centered Load Distribution

6 SIZES . . . 1/10 to 81.5 H.P.

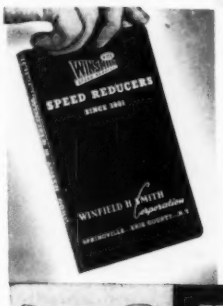
Horizontal and Vertical Types





(above)
"BT" SERIES
Horizontal
Single
Reduction
1/5 H.P. to 12½ H.P.

(at right)
HELICAL GEAR
Horizontal
Single Reduction
½ H.P. to 8 H.P.



***Send for Our Latest* POCKET-SIZE CATALOG**

It covers our complete line . . . including the new, space-saving patented Winsmith Differential Speed Reducer. Gives ratios, horsepower, torque, overhung load capacities . . . includes valuable reference material and comprehensive Engineering Section. For Catalog 148, please write on your letterhead stating position.

SEE OUR CATALOG in SWEET'S FILE

WINSMITH SPEED REDUCERS

WINFIELD H. SMITH CORPORATION

MEMBER OF AGMA

111 EATON STREET
SPRINGVILLE . . . Erie County . . .. NEW YORK

Purebon

solves many problems

caused by sliding or rotating parts which are difficult or impossible to lubricate

A constantly increasing stream of problems are facing engineers and designers today involving sliding or rotating parts where lubrication is difficult or impossible. For such applications, Purebon, the mechanical carbon, is often the ideal answer. Typical applications are seal rings, bearings, pistons, piston rings, pump vanes, valve seats, meter discs, and a host of similar items. Purebon comes in a wide variety of grades. It is strong, tough, readily machineable and in many cases can be molded directly to size.

Bulletin No. 482 tells the complete story of Purebon. Write for your copy today.

PURE CARBON CO., INC.
448 HALL AVE. ST. MARYS, PA.

Vibration SPECIALISTS

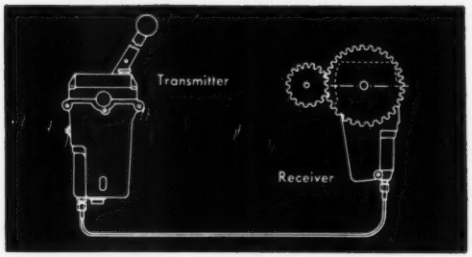
Standard Locknuts, Lockwashers and Adapters are *vibration-proof* devices for holding ball or roller bearings in place. Hard wear and tear cannot shake them loose, they are easily removed, and can be used again and again. Locknuts can be locked in a permanent and correct position by multi-prong Lockwashers.

Locknuts in sizes N-00 through AN-40 . . . Lockwashers (multi-prong type) in sizes W-00 through W-40. Write for Bulletin 27.

Adapter sizes 7-9-11-13, for shaft sizes 1 3/16" - 1 7/16" - 1 15/16" - 2 3/16".

Standard
LOCKNUT & LOCKWASHER, INC.
311 N. CAPITOL AVE., INDIANAPOLIS 4, INDIANA

Gear drive on SPERRY HYDRAULIC REMOTE CONTROL *will amplify or reduce 55° operating arc**



Putting gears or pulleys on receiver shaft of Sperry Hydraulic Remote Control permits great variation of its effective operating arc. This makes possible more accurate control of valves, indicators and similar equipment. Torque output depends on gear ratios employed.

Sperry Hydraulic Remote Control provides accuracy to ¼ of 1°. It is moisture-and-dust-resistant. Automatic synchronizing valve compensates for volumetric changes in fluid due to temperature change.

For all the facts on Sperry Hydraulic Remote Control, write today for Bulletin 2001-I-2.

*Gears are not supplied with controls.

SPERRY PRODUCTS, INC.
DANBURY, CONN.
SPERRY

FELT IS USED IN EVERY CAR ...IN EVERY AUTOMOBILE FACTORY

Lubrication — Sealing — Insulating — Cushioning — Anti-Rattle
Anti-Squeak — Sound Absorption — Polishing — Silencing — Washers
Gaskets — Liners — Channels — Weatherstrip — Packing — Filtration

1 FAN BEARING OILER. 2 WATER PUMP PACKING AND OILER. 3 GENERATOR BEARING SEALS. 4 GENERATOR AND STARTER LUBRICATING WICKS. 5 OIL FILTER. 6 BATTERY POSITIVE TERMINAL ANTI-CORROSION WASHER. 7 BRAKE BOLT OILER. 8 STEERING KNUCKLE TO TIE ROD DUST SEAL AND FLANGE JOINT SEAL. 9 STEERING ARM BEARING OILER. 10 FRONT WHEEL BEARING SEAL. 11 WHEEL BRAKE SHOE OILER. 12 CARBURETOR. 13 STEERING COLUMN GROMMET. 14 TRANSMISSION OIL SEAL WASHER. (SEAL ASSEMBLY TRANSMISSION BEARING) 15 DRIVE SHAFT DUST SEAL. 16 TOE BOARD AND FLOOR BOARD LINER. 17 CLUTCH HOUSING PAN DUST SEAL. 18 BODY TO CHASSIS STRIPS. 19 WINDSHIELD WIPER PIVOT ARM MOUNTING. 20 WINDOW LIFT LUBRICATORS. 21 DOOR PANEL INSULATOR. 22 FLOOR BOARD PARTS. 23 UNIVERSAL OIL SEAL. 24 TURRET TOP INSULATION. 25 WINDOW RUN CHANNEL. 26 REAR AXLE DRIVE SHAFT SEAL. 27 AXLE PINION DRIVE BEARING SEAL. 28 UPHOLSTERY RISER STRIPS. 29 SPRING COVER LINING. 30 REAR PANEL WEATHERSTRIP. 31 FUEL TANK STRAP GASKET.

American Felt Company
TRADE MARK

GENERAL OFFICE: GLENVILLE, CONN.
Engineering and Research Laboratories: Glenville, Conn. PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.
SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.

Write for S.A.E. Data Sheet No. 5, containing samples and full specifications of the standard S.A.E. Felts.

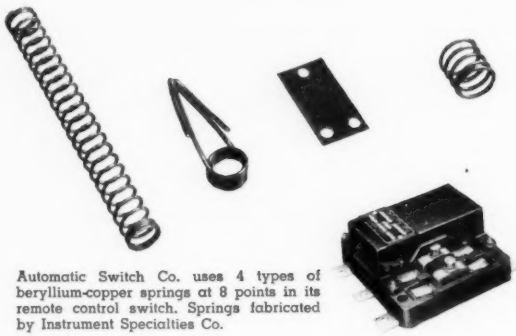
Some Additional Applications of Felt: Clutch release link lever oiler • Window anti-squeak • Fuel tank support lining • Brake shoe anchor pin washer • Drag link dust cover • Intermediate steering arm bearing seal • Windshield wiper motor washer • Toe and floor board anti-squeak • Solenoid cover gasket • Heater core to housing filler • Spindle bolt grease retainer • Spindle bolt dust washers • Radius rod felt • Hydraulic lift spring seat • Door bumpers • Pedal pads and seals • Dash liners • Oil retainers • Polishing felts, for glass, metal and paint • Door liners • Ventilator valve seals • Weather seals • Hood lace filler • Moulding shim • Timing gear cover pad • Accelerator rod pad • Fuel tank shim • Propeller shaft spline oiler • Paint filter bags • Crankcase oil filter cap • Brake dirt seals • Defroster control valve seal • Hand brake cable clamp seal • Windshield division filler • Pinion bearing retainer packing • Horn wire locator felt • Oil sabre dust washer • Fender welt felt • Spring oiler felt • Spring bumpers • Gas filling protector pads • Rocker arm seals • Chafing strips for convertible tops • Upholstery padding • Radio selector pads • Thrust bearing inserts • Cab roof lining • Antenna weather seal • Blankets for protection during assembly and service • Factory table pads • Glycerine pads for windshield wipers •

Entire Advertisement © 1948, American Felt Co.

Put High Performance

BERYLLIUM-COPPER

to work on Your Spring Problem



Automatic Switch Co. uses 4 types of beryllium-copper springs at 8 points in its remote control switch. Springs fabricated by Instrument Specialties Co.

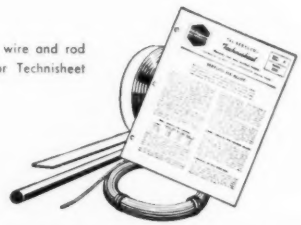
By taking advantage of the special properties of BERYLCO 25S, The Automatic Switch Company has built high efficiency into remote control switches while cutting assembly costs.

4 Springs . . . . . 4 Functions

- *LONG CORE SPRING* . . . Non-magnetic for operation in solenoid field and corrosion-resistant for out-door installation.
- *SHORT COMPRESSION SPRING* . . . Maintains desired contact pressure without set at high temperatures.
- *TORSION SPRING* . . . High strength for maximum operating power.
- *FLAT SPRING* . . . Dimensional control through fixture heat-treatment gives accurate positioning of arcing contacts.

If, in addition, your spring problem involves freedom from drift, electrical conductivity or close control of free length, coil diameter and load-deflection rate—look to beryllium-copper for the solution.

BERYLCO 25S is available in strip, wire and rod forms. For specific data, write for Technisheet No. 2.



BERYLCO BERYLLIUM BERYLCO

The **BERYLLIUM CORPORATION**

Dept. 2M, Reading 2, Pa.

F—13A

Manufacturers use the advertising pages in this magazine to get *news* about their products or services to *you*... quickly and effectively. Their advertisements contain information designed to help you do your job better, quicker, and cheaper, which is just as newsworthy as the editorial columns.

To be well-informed about the latest developments in *your* business, *your* industry...and to stay well-informed... *read all the ads too.*

McGRAW-HILL PUBLICATIONS

Get a better tubing score with Bundyweld*

Get a better score on *1*) production costs, 2) quality, and *3*) time and labor savings by checking Bundyweld Tubing.

Bundyweld *and only Bundyweld* is double-walled from a single strip of metal. Copper-brazed at all points of wall contact, thin, extra-strong Bundyweld assures less leakage under pressure, less breakage under short-radius bends. It is readily fabricated, lightweight, and easy to handle.

Here are only a few of the industries which have made Bundyweld the standard for many of their tubing applications:

Automotive—fuel, hydraulic, vacuum, and brake lines.
Refrigeration—condenser, evaporator, and compressor tubing parts.
Range—supply lines, flash and pilot tubes.
Radiant heating—panel grid tubing.

Bundyweld for television antennas; beer coils of special Bundyweld Nickel; toy baby carriages, whistling gas-tank signals—these are just a few of the applications of Bundy Tubing that are making profits for their manufacturers.

If you have a design or production problem, or a new idea for tubing, why not contact Bundy engineers to help you work it out? Just call or write: *Bundy Tubing Company, Detroit 14, Michigan.*

BUNDY TUBING

ENGINEERED TO YOUR EXPECTATIONS

* REG. U. S. PAT. OFF.

WHY BUNDYWELD IS BETTER TUBING

1 Bundyweld Tubing, made by a patented process, is entirely different from any other tubing. It starts as a single strip of basic metal, coated with a bonding metal.

2 This strip is continuously rolled twice laterally into tubular form. Walls of uniform thickness and concentricity are assured by close-tolerance, cold-rolled strip.

3 Next, a heating process fuses bonding metal to basic metal. Cooled, the double walls have become a strong ductile tube, free from scale, held to close dimensions.

4 Bundyweld comes in standard sizes, up to $\frac{5}{8}$" O.D., in steel (copper or tin coated), Monel or nickel. For tubing of other sizes or metals, call or write Bundy.

BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES

Cambridge 42, Mass.: Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.***: Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. ***Chicago 32, Ill.***: Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey***: A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.***: Rutan & Co., 404 Architects Bldg. • ***San Francisco 10, Calif.***: Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.***: Eagle Metals Co., 3628 E. Marginal Way • ***Toronto 5, Ontario, Canada***: Alloy Metal Sales, Ltd., 881 Bay St.

BUNDYWELD NICKEL AND MONEL TUBING IS SOLD BY INTERNATIONAL NICKEL COMPANY DISTRIBUTORS IN PRINCIPAL CITIES.

Whether auto-race driving or screw-driving — you waste time and speed when you have to change drivers! When you use the Reed & Prince ONE DRIVER method, you do not need to change drivers for varying screw sizes. There is no fumbling, no shifting, no wasting time. Remember, ONE Reed & Prince driver fits ALL Reed & Prince recessed head screws and bolts. Good workmen appreciate this fast, modern, efficient method — and it shows up to advantage on your time sheet.

REED & PRINCE

MANUFACTURING CO.
CHICAGO, ILL. WORCESTER, MASS.

MANUFACTURING
Recessed and Slotted
Wood Screws Sheet Metal Screws
Machine Screws Stove Bolts
Also
Cap Screws Set Screws
Machine Screw Nuts Wing Nuts
Rivets and Burrs Rods
Screw Drivers and Bits
Specialties

NOW all these features in ONE GREAT RELAY!

Independent twin contacts for perfect contact operation.

A highly efficient magnet circuit for sensitivity and high contact pressure.

Coil operating range: up to 300 volts, D.C., and 230 volts, A.C.

Any controlled circuit arrangement requiring up to 26 terminals.

Compact design for important savings in space and weight.

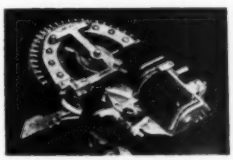
Unique armature bearing for long wear under severe conditions.

It's the Class "B" Relay

by AUTOMATIC ELECTRIC

Here's a relay that steps out from the crowd—a relay even better than Automatic's widely used, *widely copied*, Class "A" relay. Use the Class "B" for your most exacting application—and discover for yourself its wide margin of superiority in sensitivity . . . dependability . . . compactness . . . versatility . . . and long wearing qualities!

The Class "B" Relay and many others are described in catalog 4071—write for your copy.



TYPE 45 ROTARY SWITCH

A rotary switch that's new and better! 70 steps a second speed . . . up to 10 (or more) bank levels . . . only one field adjustment. Ask for literature.

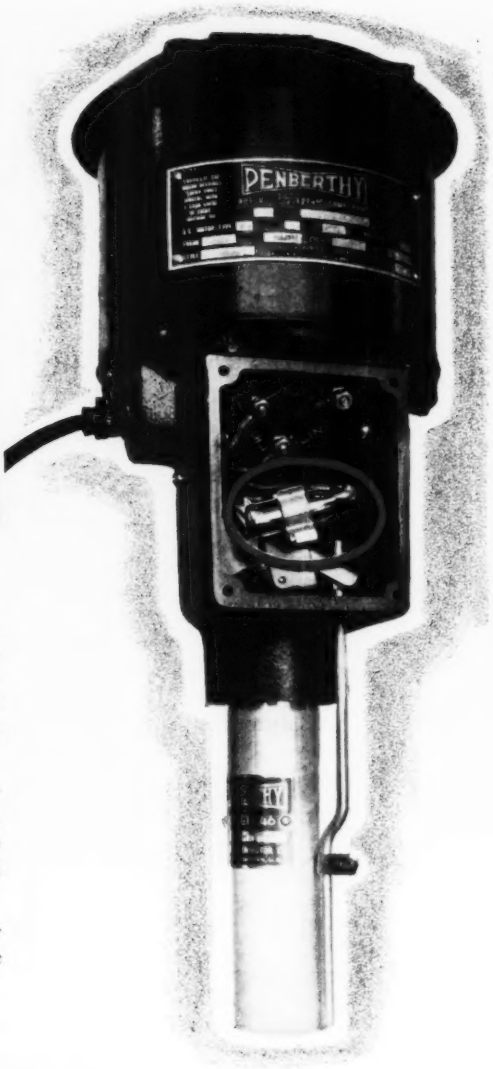
AUTOMATIC ELECTRIC

Distributors in U. S. and Possessions:
Automatic Electric Sales Corporation
1033 W. Van Buren St., Chicago 7, Ill.
In Canada: Automatic Electric (Canada), Ltd., Toronto

POSITIVE ACTION every time!

WITH THE

HONEYWELL MERCURY Switch



Sump Pumps *must operate every time* the water level float calls for action. The makers of Penberthy Sump Pumps insure positive on-off switching of the ¼ h.p. motor with a Honeywell Mercury Switch, actuated by a rod attached to a copper float. The action is simple . . . but it must work every time.

Investigate Honeywell Mercury Switches for your own special applications. They are tiny and compact . . . are adaptable to unusual mountings. They have no moving parts . . . are sealed against dust, gas and corrosion. Fouled contact points cannot occur.

Honeywell Mercury Switches give you greater latitude in product design . . . improve performance and operating efficiency. *Send for catalog.*

MINNEAPOLIS-HONEYWELL REGULATOR CO.
BROWN INSTRUMENTS DIVISION
4459 Wayne Ave., Philadelphia 44, Pa.
Offices in principal cities of the United States, Canada and throughout the world

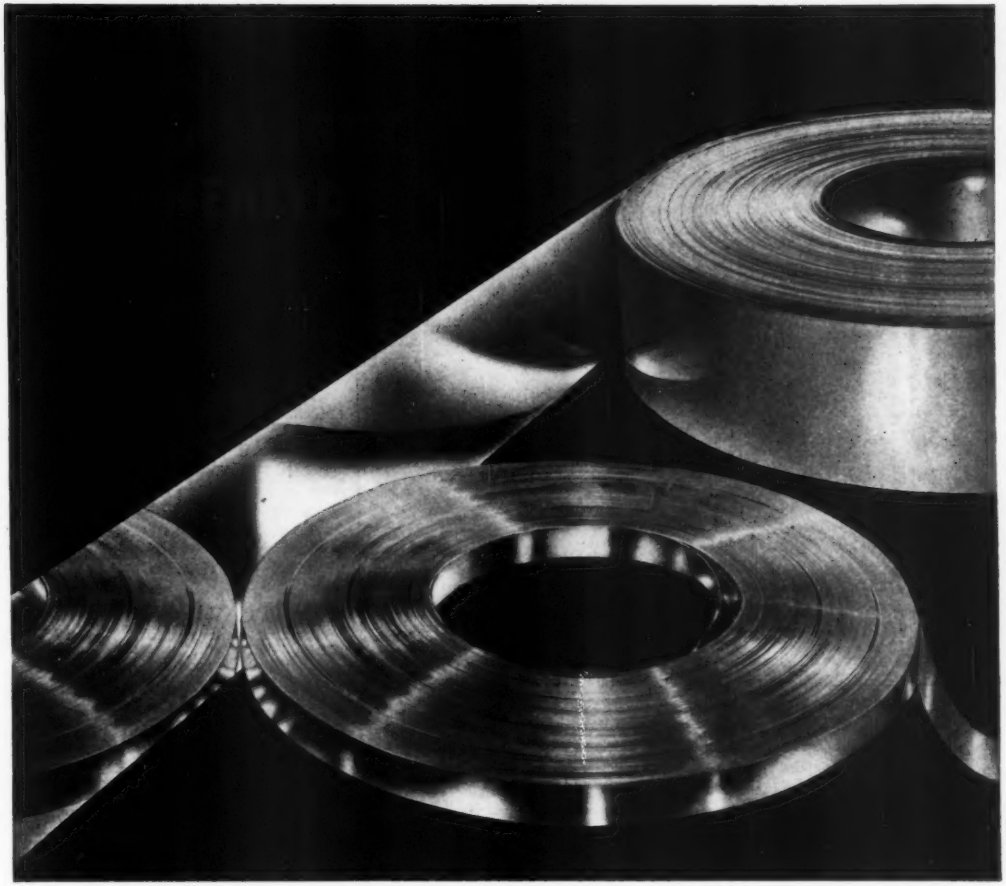
WHEN YOU WANT
- POSITIVE CONTACT
- EASE OF ACTUATION
- LONGER LIFE
- WIDE SELECTION

SPECIFY THE HONEYWELL MERCURY Switch

MINNEAPOLIS Honeywell

Mercury Switches
FOR POSITIVE ACTION

BROWN



slashes finishing costs • improves your products

Now you can get on the "bright" side, right from the start. With the exclusive new CMP bright annealed stainless THINSTEEL you can enjoy the advantages of lower finishing and fabricating costs — and the plus of increased sales appeal through improved finish and corrosion resistance.

Produced in many chrome-nickel types and in gauges thin as .001, this new THINSTEEL product broadens your opportunity for product betterment with competitive costs in mind. Would you like a sample and more information? Write today.

CMP Stainless THINSTEEL

C M P PRECISION COLD ROLLED STRIP STEEL

the Cold Metal Products co.

YOUNGSTOWN 1, OHIO

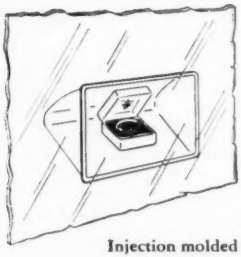
NEW YORK • CHICAGO • DETROIT • ST. LOUIS • INDIANAPOLIS • LOS ANGELES

WHAT'S NEW IN AUBURN Plastics

A new type of calculator keytop that adds much to the smart styling and functional design of the unit is molded by AUBURN for the Marchant Calculating Machine Company.

Molded of Tenite II by a double shot injection molding technique, the two-tone keytops are produced as one piece with nothing to wear off or come apart. Characters, in contrasting colors, are flush and cannot be effaced . . . and there are no surface depressions to gather dust.

The keytops are also molded in different colors with varying shapes to increase the operator's speed and accuracy.



A new idea in permanent, dust-proof window displays has been translated into plastics by AUBURN for the Niagara Lithograph Corp., patentee.

It is a small (approximately 7" x 8") transparent case designed to hold the merchandise, in its own open case, directly to the inside of the dealer's display window. Special cement applied to a groove molded into the flange on the open end makes a strong seal between window and case. Injection molded in a single cavity mold, it is an acrylic plastic, chosen for its stability at extreme temperatures, its imperviousness to sunlight and its comparative disinclination to attract dust particles.

AUBURN molds all types of plastics by any modern molding method. When you have a problem in plastics, AUBURN'S 73 years of experience is at your service. Write: Auburn Button Works, Inc., 350 McMaster St., Auburn, N. Y.

Engineered Plastics

MOLD MARK

Auburn Button Works, Inc.

MOLDERS SINCE 1876 • AUBURN, NEW YORK

your industry's BIGGEST TRADE SHOW!

Your industry's biggest trade show isn't a once-a-year event. It comes to you with *every single issue* of this magazine. And, because it is scheduled so frequently, it can bring you a continuing series of up-to-the-minute "displays." In these advertising pages, you will find the latest news about products and services that are specially designed to help you do your job better, quicker, and cheaper. To be well-informed about the latest developments in *your* industry . . . and to stay well-informed . . . *read all the ads too.*

McGRAW-HILL PUBLICATIONS

HEADQUARTERS FOR INDUSTRIAL INFORMATION

Check ALL the Features of this

QUIET... LOW COST... EFFICIENT... Sundstrand Model 5W Constant Volume Pump

Model 5W pump with "end" type porting and flange mounting.

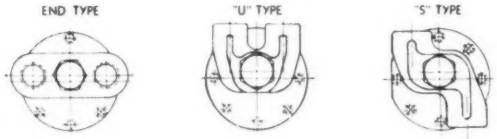
For Materials Handling Equipment, Agricultural Machinery, Industrial Heating Units, Lift Trucks and similar installations. This new pump incorporates the efficient ROTA-ROLL principle and pumping members which produce more efficient inlet port conditions, a reduction in cavitation, a quietly operating pump and longer pump life. Sundstrand ROTA-ROLL pumping members are operating quietly and efficiently in over 1,500,000 pumps today.

Available in 7 Sizes Ranging from 4 to 10 GPM.

The Model 5W is furnished in 7 different capacities ranging from 4 to 10 GPM at 1200 RPM. Capacities are determined by width of pumping members, and all 7 sizes of pumps with the same combination of porting and mounting arrangement have the same basic dimensions excepting overall length. The pump is suitable for 1200 PSI service.

3 STANDARD PORTING ARRANGEMENTS

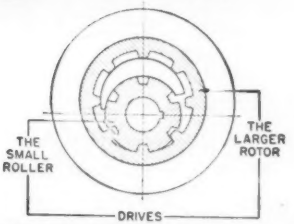
Another desirable feature of the Model 5W is its versatility in mounting and porting. The sketches below (end views) illustrate porting arrangements that can be furnished for practically any piping requirements.



AVAILABLE WITH FLANGE OR FOOT MOUNTING

Sundstrand Model 5W pumps can be furnished in several different styles of flange mounting or foot mountings.

6 OUTSTANDING FEATURES



1. ROTA-ROLL PRINCIPLE of pumping members promotes quiet operation, longer life because (see above) smaller roller is keyed to shaft and drives outer member at a speed 25% lower than motor speed.
2. QUIET OPERATION because ROTA-ROLL pumping members and efficient inlet port design reduces cavitation at the inlet port.
3. SMOOTH UNIFORM FLOW AT ALL PRESSURES because rotating roller and rotor are self-emptying, eliminating turbulence, and other interference with smooth uniform flow of oil.
4. SMALL AND COMPACT (see illustration) will lend itself to and improve your product appearance.
5. HIGH OVERALL EFFICIENCY of over 85% at maximum continuous duty pressure.
6. LOW COST, $31.50 manufacutrer's list price, f.o.b. Rockford, Illinois for the model 5W pump with direct coupling drive. When sheave or pulley type drive is required, pump can be furnished at additional cost.

Free Additional Data will be furnished on request. Write today, ask for P-38.

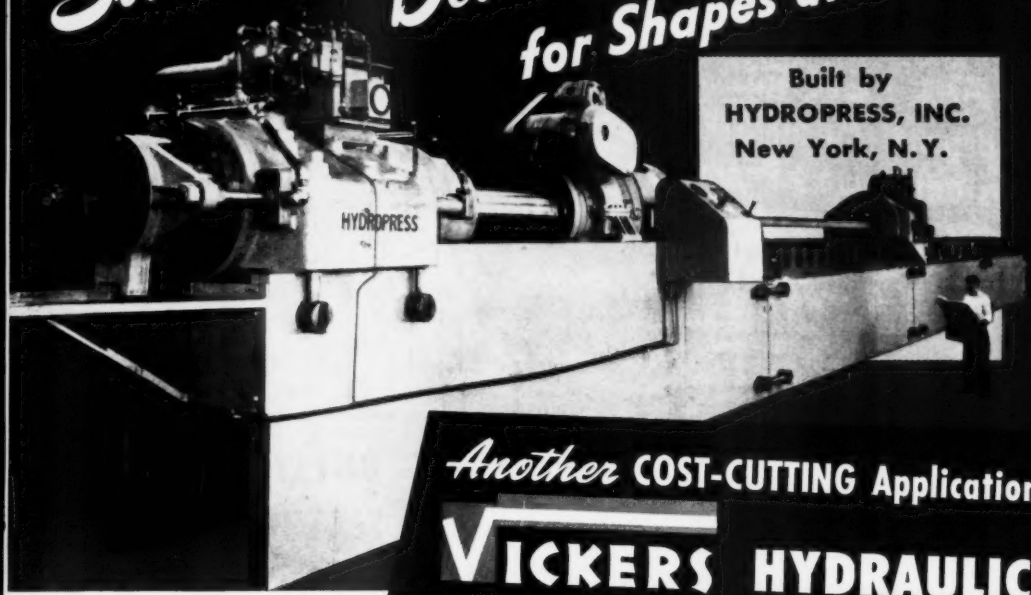
SUNDSTRAND MACHINE TOOL CO. ROCKFORD, ILLINOIS, U.S.A.

SUNDSTRAND HYDRAULIC DIVISION

2560 ELEVENTH STREET • ROCKFORD, ILLINOIS

FUEL UNITS • HYDRAULIC PUMPS • TRANSMISSIONS • FLUID MOTORS • VALVES and CONTROLS

Stretch-Straightening-Detwisting Machine for Shapes and Sections



Built by HYDROPRESS, INC. New York, N.Y.

Another COST-CUTTING Application of VICKERS HYDRAULICS

Powered by Vickers Hydraulic Power Units and controlled by Vickers Hydraulic Valves, this huge machine performs detwisting and straightening operations on structural members as long as 40 feet and with cross-section lying within a 14 inch diameter circle. The stretch-straightening and detwisting operations are performed simultaneously so that torsion is applied while the section is under tension and ready to flow. The torsional and tensional stresses are sufficient to obtain immediate flow and permanent detwisting of the material with a minimum of spring back that would occur to a great extent if torsion were applied alone.

An important feature of the machine is the arrangement of movable heads that makes it possible to detwist any part of the member if localized detwisting is necessary.

This is another of the innumerable jobs throughout industry that is being done better, faster and at less cost with the help of Vickers Hydraulic Controls. Consult the Vickers office near you for information on how Vickers Hydraulic Equipment can improve your machinery.

VICKERS Incorporated • 1454 OAKMAN BLVD. • DETROIT 32, MICHIGAN

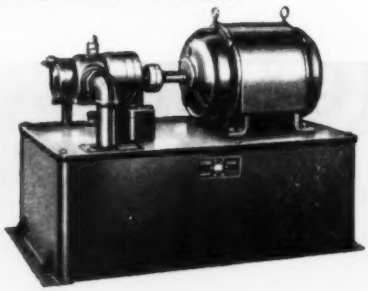
DIVISION OF THE SPERRY CORPORATION

Application Engineering Offices: ATLANTA • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • LOS ANGELES • NEWARK • PHILADELPHIA PITTSBURGH • ROCHESTER • ROCKFORD • ST. LOUIS • SEATTLE • TULSA • WASHINGTON • WORCESTER

3814

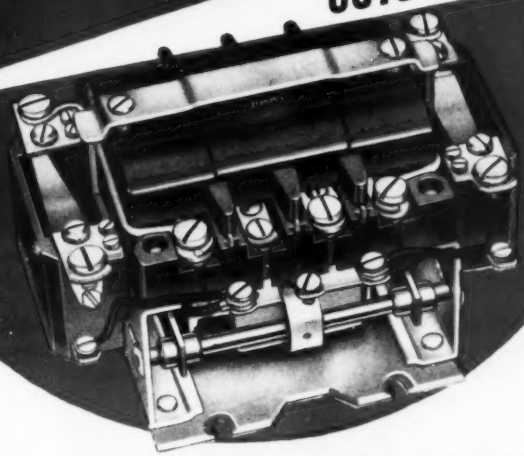
VICKERS HYDRAULIC POWER UNIT

A compact hydraulic power package that simplifies hydraulic system design and reduces costs. Available with various pump combinations to meet wide range of requirements up to pressure demands of 2000 psi. There are 92 standard sizes and types of single stage, two stage and dual pressure pumps equipped with motors from ¾ to 20 hp. Ask for Bulletin 46-43.



ARROW AH HART

NEW BALANCED MECHANISM CUTS THE SIZE IN HALF



SMALLEST "O" or "I" SIZE

MAGNETIC STARTER

TYPE 'RA', SIZE 'O' or 'I'

ONLY 6 3/16" x 6 11/16" in size of enclosure —*half the size* of vertically-operated magnetics. Sturdy, dependable, *incomparably compact.*

The *new-principle* design with balanced mechanism provides a free-floating magnet with guided contact alignment. Lever and fulcrum action multiplies the leverage, transfers magnet pull from vertical to horizontal plane and increases contact pressure.

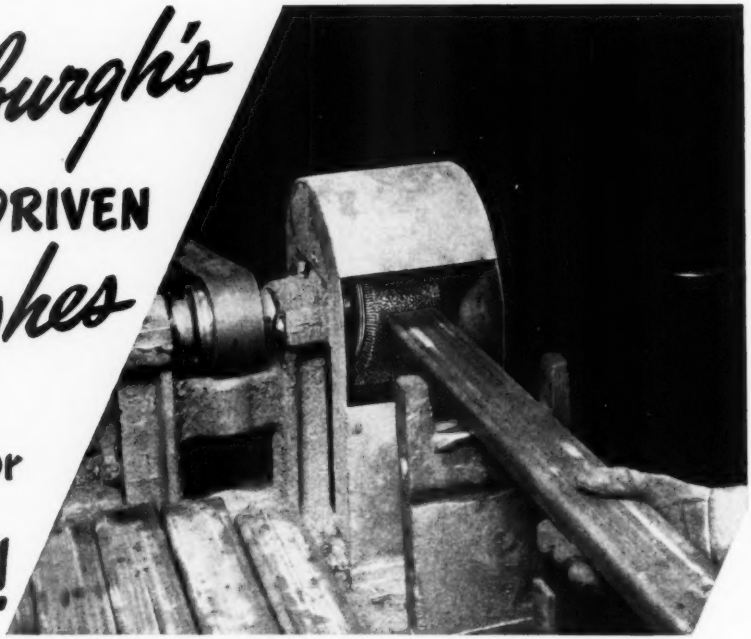
Designed for straight-through wiring, with separate contact enclosures. Provides local control for motors rated 5 H. P., 220 Volts and 7½ H. P., 440 or 550 Volts. Write for new 8-page descriptive folder on this foremost advance in *space-saving* motor controls.

ARROW AH HART

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY, HARTFORD 6, CONN., U. S. A.

Pittsburgh's POWER DRIVEN Brushes

on the job for NATIONAL ELECTRIC!



A Pittsburgh "power-driven" brush in operation at the Ambridge plant of the National Electric Products Corporation. Removing burrs, this special brush is on the job every day.

● Like many other leading industries, National Electric put their brushing problems before Pittsburgh's skilled brush engineers. Then Pittsburgh went to work to design and build a special brush for this rough assignment. The brush had to be *stiff* enough to remove burrs and scales. It had to be *tough* enough to penetrate and thoroughly clean the metal. And it had to be *rugged* enough to withstand heavy operation at high speed.

● You, too, can always depend on Pittsburgh to solve your brush problems. Its well-staffed crew of skilled engineers can solve your brush troubles quickly and effectively.

There's a Pittsburgh Brush for Every Industrial Use!

- GLASS
- STEEL
- PLASTICS
- AUTOMOBILE
- RUBBER
- PAPER
- TIRE and RETREADING
- SHOE MANUFACTURING and REPAIRING

In the complete Pittsburgh line are brushes of all types, including "Perfect Balance" sections, wheels and assemblies. Consult the Pittsburgh engineering representative. He will gladly work with you in developing any type of power-driven brushes to meet your particular finishing specifications. Write or phone Pittsburgh Plate Glass Company, 3221 Frederick Avenue, Baltimore—29, Md.

Power Driven BRUSHES

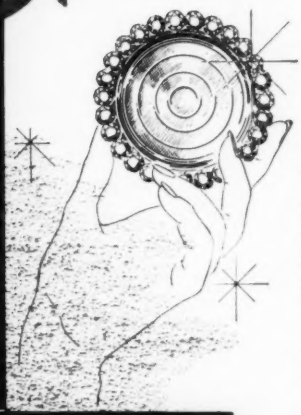
BRUSHES · PAINT · GLASS · CHEMICALS · PLASTICS

PITTSBURGH PLATE GLASS COMPANY

IT'S THE *Sparkle* THAT SELLS THE PRODUCT MADE FROM

KOPPERS

Perfected PLASTICS



PUT a sparkling dish like this in front of a woman and she'll pick it up every time. The brilliant jewel-like trim catches the light from every angle—gives the appearance of fine cut glass. And when the customer sees the low price, the urge to buy is nearly irresistible.

These dessert dishes are a product of the Plastic Jewel Company, W. Orange, N. J. They've been a quick "sell out" wherever they appear on store counters.

Much of their sparkle comes from the crystal clarity of Koppers Polystyrene. And when transparent colors are used the effect of real jewels is even more striking.

You never know when you'll hit the "jack pot" with an idea like this, but Koppers Perfected Plastics can give your product real quality . . . quality that makes customers keep on buying.

Koppers Polystyrene 8, for example, can be washed in scalding water. What's more, Polystyrene 8 has an extremely fast molding cycle. You can turn out more pieces and a higher percentage of them are perfect pieces. All sprues and runners can be ground up and used again. This makes Koppers Polystyrene 8 one of the lowest in cost of all plastics.

If you use, or are considering plastics, look at the jobs Koppers Perfected Plastics can do economically and well. Send the handy coupon for our new booklet.

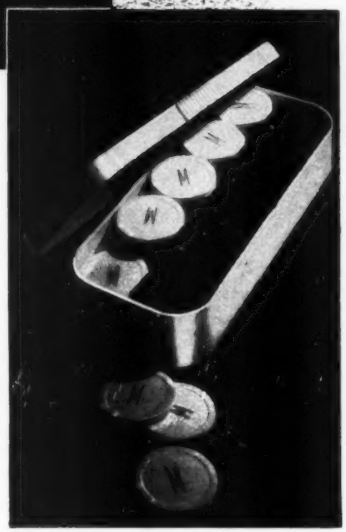
KOPPERS COMPANY, INC.

Chemical Division

KOPPERS BUILDING, PITTSBURGH 19, PA.

District Offices in New York, Chicago, and San Francisco

Sparkling simulated diamonds trim the edge of these dessert dishes and coasters made of Koppers Crystal Polystyrene. They have the extra sales appeal that means dollars in the cash register. Also available in brilliant transparent colors with coasters to match. Molded by Plastic Jewel Company, W. Orange, N. J.



An easy way to "raise" profits. That's what these colorful poker chips did for the Beacon Products Corporation, Newton Highlands, Mass. Molded of Koppers Polystyrene and sold in a handsome box of the same material.

KOPPERS *Perfected* PLASTICS INCLUDE:

KOPPERS POLYSTYRENE 8, the heat-resisting polystyrene that can be washed in scalding water.

KOPPERS POLYSTYRENE 7, the general purpose type.

KOPPERS POLYSTYRENE 3, the lubricated type for fast, easy moldability.

KOPPERS CELLULOSE ACETATE, a tough, high-strength plastic with great resistance to impact.

KOPPERS ETHYL CELLULOSE, the cellulosic with highest impact strength.

Send for New Free Booklet

KOPPERS COMPANY, INC.
Chemical Division, Dept. PE-2
Koppers Building, Pittsburgh 19, Pa.

Please send me your new booklet on Koppers Plastics.

Name_____

Company_____

Address_____

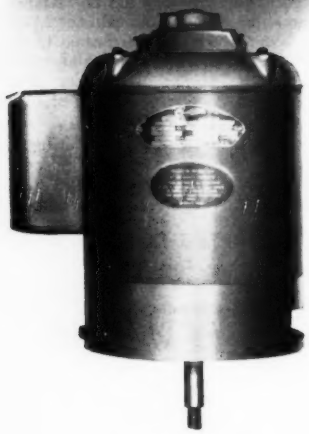
KOPPERS

Koppers *Perfected* Plastics

*POLYSTYRENE *ETHYL CELLULOSE *CELLULOSE ACETATE

Century Announces a Line of Completely NEW Jet Pump Motors

Century ½ horsepower
jet pump motor with keyed shaft



Century ½ horsepower
jet pump motor with threaded shaft

Designed for automatic starting and stopping, these motors have the starting and accelerating torque and speed characteristics especially suited to jet pump service.

The new capacitor start single phase jet pump motors are built to NEMA standards of performance and dimensions. Three phase and direct current motors have identical mounting dimensions—making them interchangeable.

Century Jet Pump motors are ruggedly constructed and carefully balanced to assure a long life of dependable operation, under the frequently abnormal conditions surrounding pump installations.

Century builds a complete line of motors in a variety of kinds and types—in sizes from 1/6 to 400 horsepower.

For complete information, call in a Century engineer. He may be able to help you with your electric power problems.

CENTURY ELECTRIC COMPANY
1806 Pine St., Saint Louis 3, Missouri
Offices and Stock Points in Principal Cities

Century C MOTORS

616

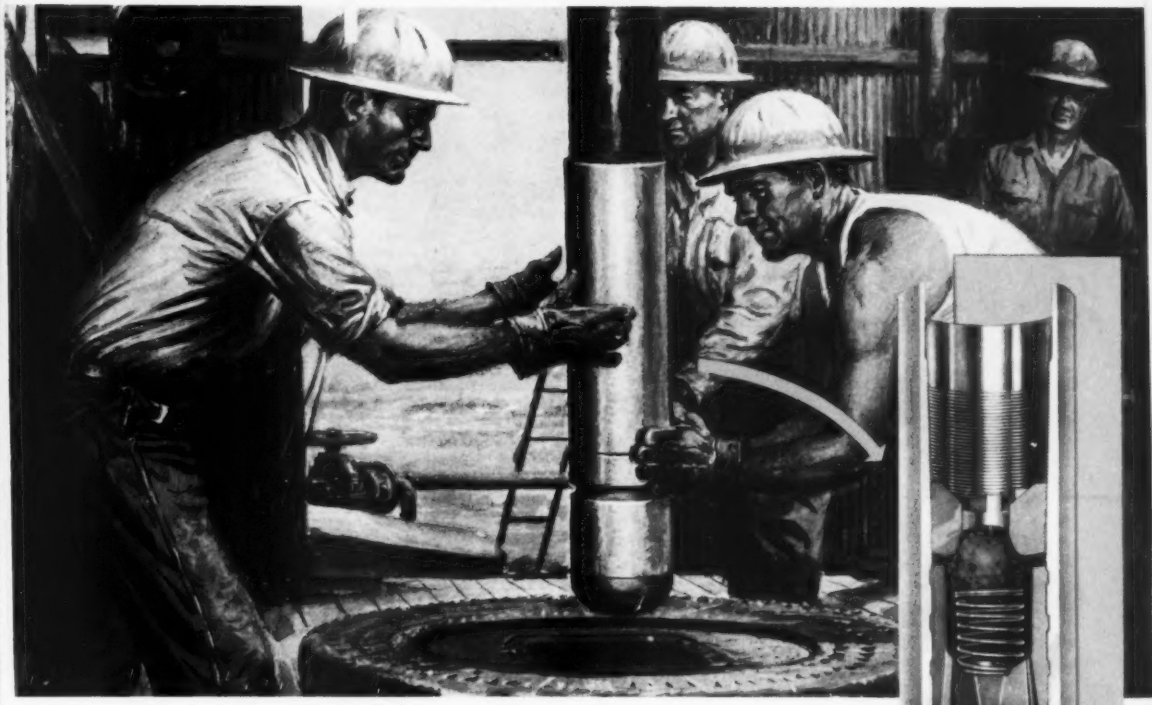
Plastics where plastics belong

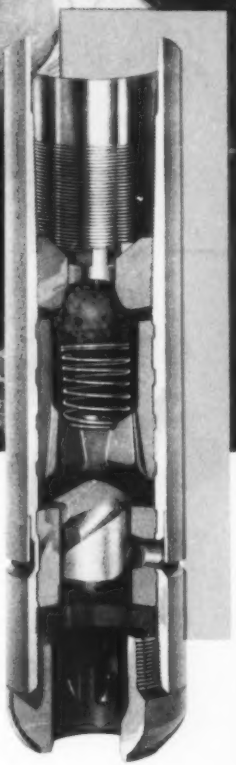
for strength, wear resistance, and ease of machining . . .

Structural strength, wear resistance, and ease of machining are three of Synthane's many properties which, in combination with its other mechanical, chemical and electrical characteristics make it one of industry's valuable materials.

A good electrical insulator, Synthane, the set plastic, is stable over a wide range of temperatures. Hard, dense and durable, it also possesses desirable moisture and corrosion-resistant qualities.

The ability of Synthane to stand up under adverse conditions is interestingly demonstrated by its use in the Turbo-Jet Float Shoe.





Various parts of Float Shoes, used in cementing oil wells, are fabricated from Synthane, for example, the valve ball and thrust plate in the shoe illustrated at the right.

Synthane resists the abrasive action of the liquid cement pumped through the shoe. It is thermosetting, so that it retains its original size and shape, yet is easily drilled out after the cement has set. Thus, Synthane's combination of strength, wear resistance, stability and ease of machining make it a perfect material for this difficult job.

If this brief review of Synthane's unique combination of desirable properties suggests its use in your product, let us help you with design, materials or fabricated parts. Write today for the new Synthane Plastics Catalog, 3 River Road, Oaks, Pennsylvania.

SYNTHANE

where Synthane belongs

SHEETS • RODS • TUBES • FABRICATED PARTS • MOLDED-LAMINATED • MOLDED-MACERATED

PORTRAIT OF A HUNTER

If you are always hunting for a better material, one which combines many valuable physical, chemical and electrical characteristics—consider Synthane laminated plastics.

Synthane has a place in almost every industry because its unusual *combination* of desirable properties can often make a good product or process better.

On a weight-for-strength basis Synthane compares favorably with many metals. It is durable, lightweight, high in tensile, compressive and flexural strengths.

Synthane resists corrosive atmospheres, moisture, oils and solvents. Synthane is also the set plastic, stable over a wide range of temperatures.

Synthane is an excellent insulator —with high dielectric strength, low power factor and low dielectric constant. The ease with which it may be machined adds to its value for practical applications.

Hard and dense, Synthane resists fatigue under repeated impact. Withstands abrasion, does not splinter.

If these properties of Synthane suggest its possible use in your product, let us work with you on materials or fabricated parts. Send Coupon for your copy of the Synthane Plastics Catalog . . . no obligation of course.

..FOR MORE ANSWERS ON PLASTICS..

SYNTHANE CORPORATION, 3 RIVER ROAD, OAKS, PA.

Gentlemen:

Please send me without obligation a complete catalog of Synthane technical plastics.

Name _____

Company _____

Address _____

City _____ *Zone* _____ *State* _____

SYNTHANE
S

DESIGN • MATERIALS • FABRICATION • SHEETS RODS • TUBES • FABRICATED PARTS • MOLDED-MACERATED • MOLDED-LAMINATED

Parker-Kalon GROUND THREAD Socket Set Screws are The TALK of the SHOP!

"As different from ordinary set screws as night and day"
"Consistently uniform — here's a Class 3 Fit you can depend on"
"True ground finish has none of the imperfections you get with cut threads"
"Clean starting threads speed assembly work and improve production"

Compare! Write for Samples!

See why P-K Ground Thread Socket Set Screws speed assemblies, improve strength and safety. Thread grinding, once reserved for screws used in the finest precision equipment, now gives Parker-Kalon Socket Set Screws the accurate finish and faultless contour that mean faster assembly and more sales for your products. Write for samples today.

AVAILABLE FOR PROMPT DELIVERY

PARKER-KALON CORPORATION
200 Varick Street
New York 14, N. Y.

SOLD ONLY THROUGH ACCREDITED DISTRIBUTORS

IT TAKES AN AHLBERG BEARING TO...

RUN RINGS AROUND FRICTION!

Anti-friction minded? Of course you are. But are you using bearings that really conquer, really **RUN RINGS AROUND FRICTION?**

Making truly superior ball bearings isn't simply a matter of "marrying" good races to good balls and good retainers. What counts is how well these basic components are **mated**—how well they are designed and engineered to "get along with each other" as life-time team mates.

Micro-analyze any Ahlberg ball bearing and you will find . . . balls that are accurate to .000025" in sphericity, matched in sets to .000025" . . "generated" raceways that assure true race curvature, perfectly matched ball paths . . . chrome alloy electric furnace steel that is meticulously heat-treated for maximum toughness without brittleness.

In all other ways, from blue print inception to final inspection, Ahlberg bearings are .

PRECISION MADE—PRECISION MATED.
Sales engineers and branches in principal cities.

AHLBERG BEARING COMPANY
3019 W. 47th Street • Chicago 32, Illinois

AHLBERG Bearings
CHICAGO
BALL BEARINGS • ROLLER BEARINGS • PILLOW BLOCKS

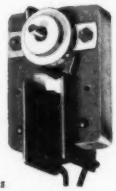
SPECIFY alliance motors for Small Load Jobs!

Fans	Toys
Business Machines	Vending Machines
Controls	Radio & television tuning
Heating Appliances	Other appliances
Turntables	

Mass production of small motors for mass markets at low cost—that's the job at Alliance!

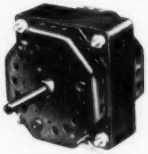
Alliance motors rated from less than 1/400 h.p. on up to 1/25 h.p. are made semi-open, and fully enclosed. Some are uni-directional and others are reversible. Motors are designed for both continuous and intermittent duty loads. Covering a wide range of standard AC voltages and frequencies, Alliance offers motors of varied types with operating characteristics to fit the specific needs of small loads. Individual changes in design are available where quantity warrants.

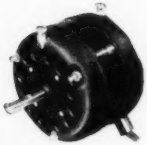
Check these advantages!
Low operating cost
Low induced hum
Low magnetic field
Low first cost
Cool running—quiet
Flexible power range
Slower controlled speeds
Long life



Write for catalog and specifications

MODEL B
4-pole shaded pole motor. Approx. 1/30 h.p. 1550 r.p.m.





MODEL A
6-pole shaded pole motor. Approx. 1/30 h.p. 500 to 1050 r.p.m.

MODEL MS
2-pole shaded pole motor — full load h.p. .0021. Full load 2800 r.p.m.

ALLIANCE MANUFACTURING COMPANY • ALLIANCE, OHIO
Export Department: 401 Broadway, New York 13, N. Y., U. S. A.

Improve Your Product THROUGH VIBRATION Fatigue Tests

MODEL 100VA
CAPACITY 100 Lbs.
Produces Vibrations Vertically

YOU can definitely ascertain how good your product is—substantiate construction and design—eliminate excessive material—through interpreting tests made on the All American Vibration Testing Machine. Eight models for handling parts or assemblies from 10 lbs. to 100 lbs. in weight. Models for vertical and horizontal movement of table. Vibration in simple harmonic motion. Standard machines produce frequencies of 600 to 3,600 v.p.m., manually or automatically controlled. Send for Catalog F. Special machines designed and built to meet your requirements.

ALL AMERICAN
Tool & Manufacturing Co.
1012 W. Fullerton Ave. • Chicago 14, Ill.

PROPER surface preparation is essential to prevent peeling and flaking of paint finishes applied over zinc coated sheets and zinc die castings.

Bonderizing produces a corrosion inhibiting surface on zinc and its alloys which effectively prevents chemical reaction between the zinc and the paint ingredients.

The nonmetallic crystalline Bonderite coating is integral with the metal itself, thus providing a secure anchor for the paint and retarding the formation and spread of corrosion.

Bonderizing for zinc is simple, economical and effective. Investigate it for your zinc production.

TECHNICAL BULLETIN AVAILABLE NOW!

Write today for details on Bonderizing for zinc. Free technical bulletin will be mailed on request.

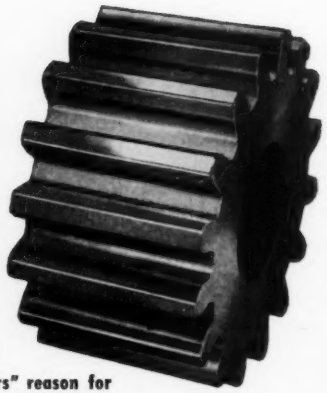
Bonderite, Parco, Parco Lubrite—Reg. U.S. Pat. Off.

PARKER

PARKER RUST PROOF COMPANY
2179 East Milwaukee Ave.
Detroit 11, Michigan

BONDERIZING Holds Paint to Metal . . . PARKERIZING Inhibits Rust . . . PARCO LUBRIZING Retards Wear on Friction Surfaces

Ampco Bronze Gears



last longer, cut replacement costs

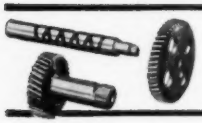
. . . a "common-sense and dollars" reason for making all your gears from Ampco Bronze alloys

You can count on Ampco Bronze to stand up under the most brutal punishment. This extra stamina is all-important *in any gear*—from a thimble-size drive for a fishing reel to the rolling-mill gear which is illustrated below.

Whether you are designing a new gear or rebuilding old equipment, play safe by selecting the Ampco alloy and form that fit your needs. Get a gear that stands up under impact and fatigue with unbelievable resistance to wear—that outlasts any gear on the same job. Ask your nearest Ampco Field Engineer for recommendations and assistance.

SAND-CAST AMPCO METAL—Massive 2416 lb. worm gear which plays a critical part in the "screw-down" mechanism of a giant size rolling mill.

CENTRIFUGAL CASTING (including teeth)—Used as a boom hoist gear on large excavating shovel. Withstands wear, fatigue, shock, and abrasion caused by dust, dirt, and loading.



EXTRUDED AMPCO METAL—Tiny drive-gears and level-wind gears for a fishing reel; designed to give perfect performance and service under widely varied conditions.

WELDED ASSEMBLY — An Ampco centrifugally-cast ring welded to a mild steel hub and web with Ampco-Trode 10.

***CONTINUOUS-CAST AMPCOLOY**—Bronze rim with die cast aluminum hub and web. This eccentric gear is proving its value by giving long, satisfactory service in many automatic home washers—and at a savings to the manufacturer.

*Produced by American Smelting and Refining Co. under a patented process.

AMPCO

Ampco Metal, Inc.

Dept. PE-2 • Milwaukee 4, Wisconsin

Field offices in principal cities.

Detailed information on Ampco Metal and Ampco Bronze alloys

TEAR OUT THIS COUPON AND MAIL TODAY!

Please send me a free copy of your Bulletin 95.

Name ..... Position.....

Company.....

Street Address.....

City.....( ) State.....

LITTLEFORD WELDMENTS for High Quality Products

When designing new products remember Littleford can fabricate plain or alloy plate and sheet metal into any size or shape Weldment to fit your needs. Littleford Weldments for 68 years have played a vital part in many a product, such units as Bases, Guards, Pans, Louver Covers, or Special Parts have been produced at low cost by precision work and know how. Experience in bending, forming, shearing and welding is assurance of the high quality Weldments. Send blue prints to Littleford for estimates.

FABRICATORS OF PLATE AND SHEET METALS

LITTLEFORD

LITTLEFORD BROS., INC.

506 E. Pearl Street, Cincinnati 2, Ohio

You don't have to Wish for Efficiency

Bearing performance becomes a reality when you use the Norma-Hoffmann "Cartridge" Bearing in your products. This double-row width bearing has 100% greater grease capacity than conventional bearings. The highly efficient seals lock grease in . . . keep dirt out. Carefully factory-packed with Norma-Hoffmann's specially compounded grease assures high antifriction performance for years on end. These are but a few of the reasons why the Norma-Hoffmann "Cartridge" Bearing is *"America's No. 1 Sealed Bearing."*

Norma-Hoffmann

AMERICA'S NO. 1 SEALED BEARING

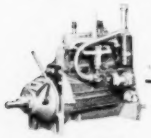
NORMA-HOFFMANN BEARINGS CORP.
Stamford, Connecticut

Field Offices: New York • Chicago • Cleveland • Detroit
Pittsburgh • Cincinnati • Los Angeles • San Francisco • Dallas
Seattle • Phoenix

WIDE CHOICE OF POWER

...Stationary or Mobile

Many different models and sizes of Allis-Chalmers engines and tractors to choose from, with accessories to fit the application.

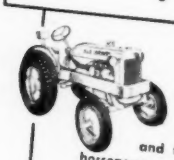


★ POWER UNITS

Designed for tough tractor service, high in torque, A-C heavy-duty power units provide rugged power for every type of job, steady or intermittent. Available in open or enclosed styles, with various accessories. Choice of fuels — gasoline, low-grade fuel, natural gas or butane.

FIVE SIZES

Model	Cylinders	R.P.M.	Max. Brake HP.
B-125	4	1500-1800	24.5 - 28
W-201	4	1400-1800	33.5 - 40.5
U-318	4	1200	45
E-563	4	1050	74
L-844	6	1050	110

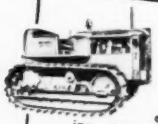


★ WHEEL TRACTORS

Popular, economical Allis-Chalmers wheel tractors provide mobile power you can depend upon, at the drawbar or power take-off. Available in 4-wheel and tricycle designs. Various speeds and horsepower ratings. Mounted on rubber tires. Electric starting and lights, other accessories as desired. Gasoline, kerosene, or distillate.

FIVE MODELS

Model	Drawbar HP.	Max. Speed MPH	Max. Belt HP.	R.P.M.
IB	13.5	10.0	16.3	1400
B	13.5	10.0	16.3	1400
C	13.5	7.06	23.3	1500
WF	23.7	9.77	29.93	1300
WC	23.7	9.77	29.93	1300



★ CRAWLER TRACTORS

Powerful, smooth-operating, these A-C 2-cycle Diesel crawler tractors hang onto overloads with the tenacity of steam power. Operate on ordinary Diesel fuels, require less gear shifting, start instantly. Positive seal truck wheels and idlers require lubrication only once in 1000 hours.

FOUR MODELS

Model	Drawbar HP.	Max. Speed MPH	Max. Belt H.P.	R.P.M. at Max. Torque
HD-5	40.26	5.47	50.25	800-1200
HD-7	60.10	5.00	71.08	800-1200
HD-10	86.63	6.03	101.62	800-1200
HD-19	*	7.00	*	800-1200

*Hydraulic Torque Converter Drive—163 HP. at the flywheel.

ALLIS-CHALMERS
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

$5.07 saved a contract ...and a man's business

Special switches were needed to complete an electrical instrument contract. Late delivery of finished items would kill chances of future orders. Switches were 1100 miles away, but Air Express delivered the 15-lb. package 8 hours after pick-up. Cost, only $5.07. Air Express now used regularly. Keeps down inventory, improves customer service.

Low as $5.07 was, remember Air Express rate *included* door-to-door service, receipt for shipment and more protection. It's the world's fastest shipping service that *every* business uses with profit.

World's finest Scheduled Airline fleet carries Air Express. 24-hour service—speeds up to 5 miles a minute. Direct to over 1000 airport cities; air-rail for 22,000 off-airline offices.

Facts on low Air Express rates

17-lb carton of hearing aids goes 900 miles for $4.70.
12 lbs. of table delicacies goes 600 miles for $2.53.
(Same day delivery in both cases if you *ship early.*)

Only Air Express gives you all these advantages: Special pick-up and delivery *at no extra cost. You get a receipt for every shipment* and delivery is proved by signature of consignee. One-carrier responsibility. Assured protection, too—valuation coverage up to $50 without extra charge. Practically no limitation on size or weight. For fast shipping action, phone Air Express Division, Railway Express Agency. And specify "Air Express delivery" on orders.

SPECIFY AIR EXPRESS
GETS THERE FIRST

Rates include pick-up and delivery door to door in all principal towns and cities

AIR EXPRESS, A SERVICE OF RAILWAY EXPRESS AGENCY AND THE
SCHEDULED AIRLINES OF THE U. S.

OHIO GEAR

DISTRIBUTORS AND REPRESENTATIVES

*Akron, Ohio
Hardware & Supply Co.
Buffalo, N. Y.
F. E. Allen
*Buffalo, N. Y.
S. H. Pooley Belting Co.
Chicago 7, Illinois
Schrade-Batterson Co.
*Dayton, Ohio
E. C. Hawk Co.
Detroit 26, Mich.
George P. Coulter
*Detroit 6, Michigan
Eynon-Dakin Co.
*Findlay, Ohio
Bearing & Transmission Co.
*Hagerstown, Md.
Hagerstown Equipment Co.
Indianapolis, Indiana
A. R. Young
*Los Angeles, Calif.
J.W. Minder Chain & Gear Co.
Louisville, Ky.
Alfred Halliday
Milwaukee, Wisconsin
R. W. Ballentine
*Minneapolis, Minn.
Industrial Supply Co.
*New York City 13, N. Y.
Patron Transmission Co. Inc.
F. Raniville Company
241 Pearl St., N. W.
Grand Rapids, Michigan
*North Kansas City, Mo.
Sesco Engineering & Supply
Pawtucket, Rhode Island
George G. Pragst
*Philadelphia 6, Pa.
Robert L. Latimer Co.
*Philadelphia 6, Pa.
Rothman Belting & Equipment Co.
*Pittsburgh, Pa.
Standard Machinists Supply Co.
*Portland, Oregon
J. W. Minder Chain & Gear Co.
*Rochester 4, N. Y.
H. M. Cross and Sons
*San Francisco, Calif.
The Adam Hill Co.
*St. Louis, Mo.
The Essmueller Co.
*Syracuse, N. Y.
Uplinger and Sherman
Toledo, Ohio
The Bearing & Transmission Co.

IN CANADA

*Montreal, Quebec, Canada
John Braidwood & Sons, Ltd.

Stocks Carried

Nationally known Ohio Gears and Speed Reducers are nearer to you than ever before. Alert distributors, with comprehensive stocks offer the famous Ohio Gear "Off the Shelf Service" in nearly every industrial center across the continent.

No farther than your phone, you'll find Ohio Stock Gears in spur, helical, bevel, worm and worm wheel types and Speed Reducers in single and double reductions in 1/6 HP to 10 HP and in ratios from 3-1 to 3200-1. You'll also find sound, capable engineering service as well as prompt attention to your needs.

Put the money-saving advantages of Ohio Stock Gears and Reducers to work for you now. Phone the nearest distributor or write direct.

ESTABLISHED 1915

THE OHIO GEAR COMPANY

1325 EAST 179th STREET • CLEVELAND 10, OHIO

OHIO GEARS

TIME as a factor of CONTROL in Industry

SHOES FITTED BY X-RAY

. . . Another Application of Cramer Timers

The compact, easy-to-operate Primex X-Ray Shoe Fitter shows at a glance the relationship of foot to shoe . . . permits the customer to see with his own eyes that he has been properly fitted. This convenient device eliminates doubt about the salesman's recommendations, reduces the frequency of returned goods because of misfitting.

The Primex is equipped with a Cramer CF2 Cycle Timer that controls the length of operation of the X-Ray unit . . . prevents overexposure of the customer . . . makes it impossible for the tube to be left burning, an important factor in prolonging tube life. Driven by a Cramer Synchronous Motor, the CF2 Timer performs this vital function with the same accuracy and dependability that is built into all Cramer time and control devices.

ANOTHER VERSATILE CRAMER CYCLE TIMER

— Type VF — controlled by a Cramer Synchronous Motor, consists of multi-contact open blade contacts that alternately open and close circuits in accordance with a pre-set program. It is adapted to a wide range of applications . . . hair-waving equipment, drink dispensing machines, commercial glass washing machines, etc.

A Widely Used Cramer Device
TYPE SX SYNCHRONOUS MOTOR

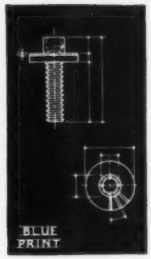
This compact precision-built permanent magnet type motor is a superior power plant for time control instruments requiring constant speed at a given frequency. For complete information, write for Bulletin 108.

IF THE PERFORMANCE OF YOUR PRODUCT DEPENDS ON PRECISION TIMING, CONSULT . . .

Cramer

THE R. W. CRAMER COMPANY, INC.
Box #7, Centerbrook, Conn.

9CR48



IF IT'S SPECIAL SEE PROGRESSIVE

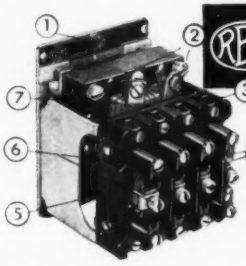
QUALITY PROMCO BRAND

ENLARGED VIEW

KEEP YOUR COSTS DOWN

Progressive specializes in manufacturing special heads, threads and finishes on any metal or alloy adapted to cold upset. Please write for catalog showing many Progressive specials. Catalog includes purchasing and engineering helps.

The PROGRESSIVE MANUFACTURING CO.
48 NORWOOD ST.
TORRINGTON, CONNECTICUT



RBM INDUSTRIAL CONTACTORS

2 TO 8 POLE
600 VOLT A. C.
10—15 AMPERE SIZES
REVERSING—NON-REVERSING TYPES
INTERCHANGEABLE CONTACTS

1. Heavy steel base.
2. Coil readily replaced by removing 2 heavy screws holding E-shaped magnet frame.
3. Accessible solderless type terminals are conveniently located. All line terminals at top; load terminals at bottom.
4. Any pole can be changed from normally open to normally closed, or vice-versa, without additional parts.
5. Melamine stationary contact block and movable contact carrier.
6. Stationary and movable contacts can be readily replaced with use of screw driver only and without removing wiring.
7. Vacuum impregnated magnet coil designed for continuous 50/60 cycle service.

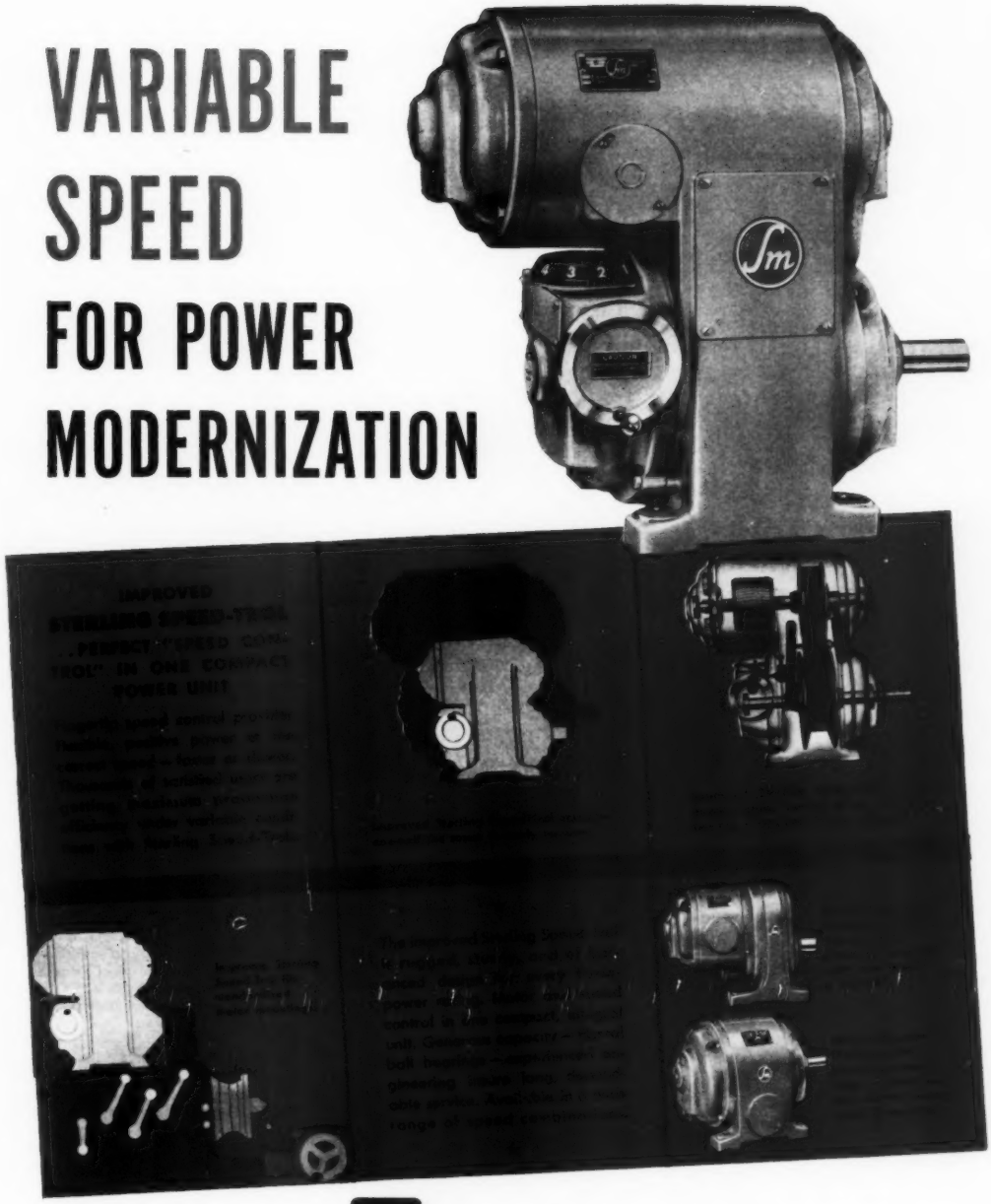
For descriptive bulletin No. 600 write Dept. E-2

R-B-M DIV., ESSEX WIRE CORP.
LOGANSPORT, INDIANA

RBM

MANUAL AND MAGNETIC ELECTRIC CONTROLS
—FOR AUTOMOTIVE INDUSTRIAL COMMUNICATION AND ELECTRONIC USE

VARIABLE SPEED FOR POWER MODERNIZATION



STERLING ELECTRIC MOTORS

GENERAL OFFICES: LOS ANGELES 22, CALIFORNIA

New York 7 • Chicago 6 • Detroit 2 • San Francisco 5 • Philadelphia 7 • Boston 9
Seattle 4 • Cleveland 15 • Pittsburgh • Cincinnati 2 • Atlanta 5 • St. Louis 8 • Houston
Milwaukee 2 • Memphis • Kansas City 2 • Minneapolis 15

Canadian Sterling Electric, Ltd., Hamilton, Ontario, Canada

Representatives in Principal Cities and Foreign Countries

Newest

LOWER-COST ROLLER BEARING... ROLLS TRUER! LASTS LONGER!

ROLLWAY

Tru-Rol

Guide Lips give True Rolling

Here's a new low-cost bearing that's an efficient running mate for Rollway's famous bronze retainer bearings. It's been thoroughly tested and proved . . . gives remarkable performance in those uses where there has to be just the right balance between the economy and precision factors of bearing selection.

Maintained Alignment

The "Guide-Lips" on Rollway's TRU-ROL roller bearings are curved flanges, deep and broad in the retainer pockets.

They guide each roller in truer alignment. They convey a thin film of lubricant to each roller . . . and keep it there. They maintain correct roller alignment; reduce wear and maintenance costs.

Tru-Rol
The new lower-priced bearing with top performance!

ROLLWAY
BEARING COMPANY, INC.
SYRACUSE, N.Y.

Sales Offices: Philadelphia • Boston • Pittsburgh • Cleveland • Detroit • Chicago
Minneapolis • Birmingham • Houston • Los Angeles

LOST!

3 BILLION DOLLARS EVERY YEAR

HOW MUCH DO YOU CONTRIBUTE TO THIS?

The annual toll taken by the elements that cause rust and corrosion is staggering. How much of this are you *needlessly* paying in costly replacement and maintenance *because you didn't* provide protection for exposed installations and equipment?

Hot-Dip Galvanizing Seals in the Base Metal

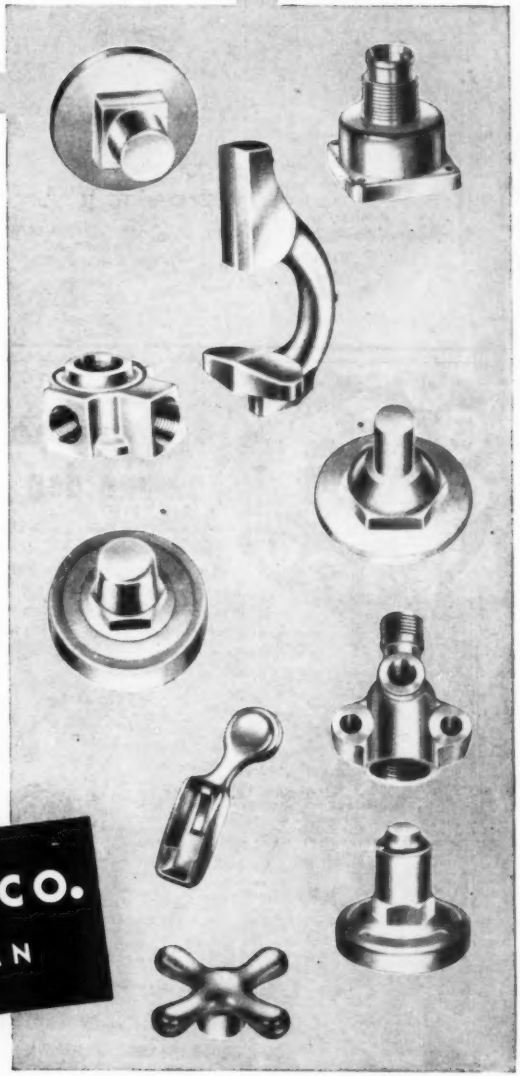
When base metal is encased in rust-preventing zinc by the Hot-Dip Galvanizing process the ravages of rust and corrosion can't touch the metal because it is *sealed in.* Rust and corrosive elements are *sealed out.*

Write for Membership Roster

Every member of this Association has the cumulative experience of the entire membership at his disposal. He has the most modern equipment and a trained organization that are at your service. For membership roster, write The Secretary, American Hot Dip Galvanizers Association, Inc., First National Bank Building, Pittsburgh, Pa.

hot-dip
GALVANIZING

Mueller Brass Co. Forgings Build Quality and Strength into YOUR PRODUCT



Brass Forgings are much stronger than brass sand castings, and very often manufactured products that have been made of sand castings can be redesigned and more advantageously made from brass forgings.

Here are some of the reasons:

Forgings are free from scale, burned-in sand, and hard spots; therefore, tools last approximately three times longer without grinding.

Made in dies, dimensions can be held to very close tolerances. There is less material to remove and less machining.

Slots and corrugations can be put in during the forging operation much more accurately, thus saving costly jigs and milling fixtures and increasing fixtures and increasing production.

Intricate depression or pocket designs of considerable depth can be forged. A big saving in costly milling operations and tools.

Because of great tensile strength, lighter parts can be used, thus reducing surplus material costs.

Forged parts can be prepared for nickel or chrome plating with much less polishing.

The fatigue point of brass forgings is much higher than that of sand castings—a superior feature where service is constant and vibration great.

Complete absence of porosity eliminates leakage.

Physical properties are practically equal to steel without the disadvantage of rusting.

Possibly you have a problem that is not being successfully solved with the use of castings. Let us suggest that you send us blueprint or sample for inspection. We are equipped to forge, completely machine, polish, buff, lacquer, or plate with modern facilities for producing complete assemblies from the virgin metal to the finished product.

MUELLER BRASS CO.

PORT HURON, MICHIGAN

MARTIN-HUBBARD CORPORATION

Engineering Consultants

Computers — Servomechanisms

Instrumentation for Nuclear Research

Applied ultrasonic research and development

Design and construction of scientific instruments
to your performance specifications

Complete engineering of original or unique electrical
and mechanical devices and machinery

Technical reports

11 BEACON STREET

BOSTON 8, MASSACHUSETTS, U. S. A.

Telephone: CApitol 7-6990 Cable Address "MARHUB-Boston"

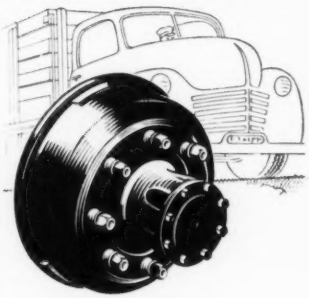
...to quote or counsel on molded plastics

Your Watertown man is an expert in plastics, backed by 34 years of experience with every type of plastic, every type of molding method. Calling him in to quote or consult on any part, product *or idea* involving molded plastic won't cost you a cent . . . will give you the benefit of our design and engineering skill, as well as our laboratory — second to none in the industry — in developing and producing the job to your satisfaction and your customers'.

If you have a custom molded plastics job on the fire, phone your nearest Watertown man today . . . or phone or write us directly. Here are the Watertown men . . .

NEW YORK – H. A. Rankow, 175 Fifth Ave.
CHICAGO – National Insulations Company, 2808 W. Lake St.
G. W. Glaescher J. P. Greener R. C. Farquhar
J. P. Bonnamy J. R. Kallaher
DETROIT – J. P. Greener from Chicago
CLEVELAND – Carl F. Linn, 866 Hanna Bldg.
MILWAUKEE – Roger L. Miller, 729 N. Broadway
SEATTLE – John W. Witherow, National Vulcanized Fibre Co.
1927 First Ave., South
SAN FRANCISCO – G. W. Harmssen, National Vulcanized Fibre Co.
273 Seventh Ave.
LOS ANGELES – Fred M. Foley, National Vulcanized Fibre Co.
2325 East Eighth St.

THE WATERTOWN MANUFACTURING CO.
500 ECHO LAKE RD., WATERTOWN, CONN.



Wear- and heat-resistance –together

The addition of Molybdenum to cast iron has specially applicable effects where good resistance to wear must be combined with least susceptibility to cracking under sudden changes of temperature.

Brake drums, for instance: here is a well-proved composition, 3.70% Total Carbon, 1.80% Silicon, 0.80% Manganese, with 0.50% Chromium and 0.70% Molybdenum added.

This is one of the many suitable economical compositions in our new booklet, "Applications of Molybdenum Cast Irons." The busy foundryman and engineer will find the alphabetical listing useful—write for a copy!

Climax Molybdenum Company
500 Fifth Avenue
New York City

Please send your **FREE BOOKLET** "Applications of Molybdenum Cast Irons"

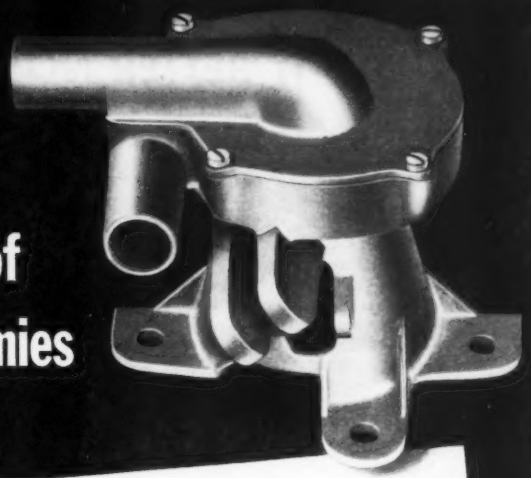
Name.....

Company.....

Address.....

PE2 F 11

DIE CASTING
delivers a steady stream of Production Economies



CASE HISTORIES FROM MT. VERNON FILES

And here's a pump to prove it. Says Apex Electrical Manufacturing Co., to whose specifications this unit is made: "The advantages obtained through use of die castings are:

1. Decrease in number of machining operations necessary.
2. Faster machining — more pieces per hour.
3. Less tool (drills, taps) breakage.
4. Reduced frictional losses in pump flow channels.
5. Better product design, due to closer tolerances, without additional cost.
6. Greater inlet and outlet cross sectional areas because of thinner wall sections (not possible with sand castings).
7. Weight decrease.
8. No corrosive problem.

Remember these facts about this pump in the famous Apex "Spiral Dasher" Washing Machine when next you consider a production procedure. Here at Mount Vernon, we have specialized knowledge and wide experience that will help you to speed output, drive down unit costs, deliver much better products to your customers. Write us today.

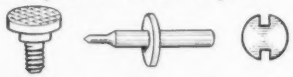
MT. VERNON
DIE CASTING CORP.
MT VERNON, NEW YORK

for safety later

DO IT BETTER NOW!

SPRINGS are the "life" of a design. On their own power, they pull, push, open, close—actuate vital parts of mechanism. When they fail, so does the product!

For safety, springs should be ***designed into*** the product, after the right type, size and metal have been determined. Generally, this is an engineering job, and if you are not set up to do it, you are welcome to this assistance as a "plus" with your order. Just send us a description of the device, preferably with sketch or blue print.



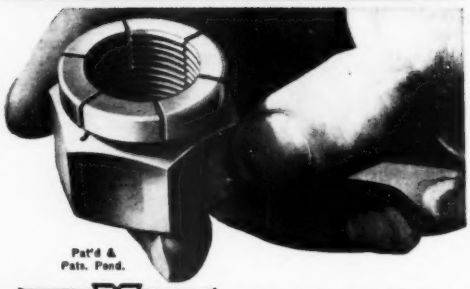
SCREW MACHINE PRODUCTS—The foregoing applies very largely to screws, nuts, turnings, pins, knobs, handles and the thousands of other parts made on modern screw machines, and the same engineering service is yours if you wish it.

PECK

SPRINGS & SCREW MACHINE PRODUCTS

THE PECK SPRING COMPANY 33 Summit St., Plainville, Conn.

ASK FOR SAMPLES



Pat'd & Pats. Pend.

FLEXLOC ONE-PIECE SELF-LOCKING NUTS

The one-piece, all-metal, resilient "Flexloc" is becoming widely accepted, because it is processed to have an exceptionally uniform torque, and because it is a stop, a lock and a plain nut all in one. All its threads are "live" and load-carrying; "Flexloc" accommodates itself to a wide range of thread tolerances, and can be used over and over again without losing much of its torque . . . is not affected by temperatures commonly met within the industrial field of Mechanical Engineering . . . and being a "stop" nut, it stays locked in any position on a threaded member . . . and last, but not least—it won't shake loose!

The *Thin* "Flexloc" has become very popular because its *tensile* is so high and the space it occupies so small.

Sizes from #6 to 2" in diameter—in "regular" and "thin" types—in NC and NF thread series. Write for *"Flexloc" Catalog*.

OVER 46 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNSYLVANIA, BOX 545

Chicago • Detroit • St. Louis • San Francisco

Reprints Available!

EXPERIMENTAL STRESS ANALYSIS SYMPOSIUM

A 16-page insert, featuring histories of applications of experimental stress analysis methods which resulted in design improvements, appeared in the December 1946 issue of *Product Engineering*.

For those who would like copies of this insert for distribution among their technical staffs, a limited supply of reprints is available at 15c each. Write to Readers' Service.

●

PRODUCT ENGINEERING

330 West 42nd St.,
New York 18, N. Y.

FOR SOMETHING EXTRA

MORSE *silent chain* COUPLINGS

IF YOU'RE looking for something extra in chain coupling performance, look no further.

The Morse Silent Chain Coupling gives you that "extra something" in durability, ruggedness, and long, trouble-free service life. The Morse Silent Chain Coupling is one of the biggest sellers in the flexible coupling field—and small wonder when you see its advantages.

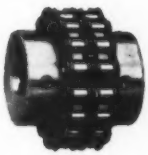
With a torque capacity normally greater than that of the shafts on which it is mounted, the Morse Silent Chain Coupling secures its flexibility through design. Load distribution through the many chain links and pins to the wide surfaces of the sprocket teeth assures small unit stresses.

The Morse Silent Chain Coupling is easy to install and disconnect. The chain may be removed without disturbing the sprocket halves, or either sprocket may be removed endwise without disconnecting the chain. Protective casings (interchangeable between Silent Chain and Roller Chain Couplings), either stamped steel or plastic, are available for use in continuous, high-speed operations. They are easily installed and provide sealed-in lubrication plus maximum protection from dirt, grit and water chemicals. All standard bore sizes can be met from regular stock.

New! Informative catalog on Morse Silent Chain and Roller Chain Couplings—complete engineering and application data. Write for catalog C45-48. Morse Chain Company, Dept. 303, Detroit 8, Michigan.

• • •

Morse Roller Chain Couplings . . . Consisting of two steel sprockets with hardened teeth, wrapped with a strand of Morse Standard double-width roller chain, the Morse Roller Chain Coupling is another big seller in the Morse line. Rugged and economical, it provides flexibility and large capacity in applications of moderate speeds and steady loads.



Morflex Couplings

Roller Chain Drives

Morse-Rockford Clutches

MORSE

MECHANICAL *POWER TRANSMISSION* PRODUCTS

A PRODUCT OF B-W BORG-WARNER

Morflex Radial Couplings

PERKINS *custom-cut* GEARS
improve your products

Whether used in small household appliances or huge machine tools, the dependability and uniformity of Perkins Precision Gears mean performance-stability in the finished product.

Precision engineering and manufacturing "know-how", backed by proper equipment have kept Perkins Gears tuned to the demands of many industries. In the interest of improved products, let us quote on your gear requirements. YOU FURNISH THE SPECIFICATIONS—WE'LL PRODUCE THE GEARS!

• **PERKINS MAKES,** *in all materials, metallic and non-metallic:*
Helical Gears, Bevel Gears, Ratchets, Worm Gears, Spiral Gears, Spur Gears, Ground Thread Worms

PERKINS MACHINE & GEAR CO.
SPRINGFIELD 2, MASS.

YES, Mr. Employer
Disabled Are Valuable

IT'S GOOD BUSINESS TO EMPLOY DISABLED VETERANS
NATIONAL HEADQUARTERS—*Cincinnati, Ohio*

The Latest News of Science Now Yours in One Big Magazine!

Now at last you can keep up with the new inventions and discoveries of science that affect you and your industry. Every month *Science Illustrated* is filled with new advances in vital fields... Electricity, Construction, Aviation, Atomic Energy, Radio, Synthetics, Mining, Chemistry, Electronics, Home Appliances, etc.

Science Illustrated shows you new products and designs and explains *why, when* and *how* they were made. Every monthly issue is packed with 30 complete, authentic articles and 140 photographs, diagrams.

ORDER NOW AND SAVE $4!

You can order 36 big issues of *Science Illustrated* (3 full years) for ONLY $5! This special rate *saves you* $4 over the one-year price. We'll start your subscription with the big new issue now on the press—*if you order within 10 days!*

MAIL THIS ORDER FORM TODAY!

Science Illustrated
330 West 42nd Street, N. Y. 18, N. Y.

YES! I accept your special offer. Start my subscription to Science Illustrated with the new issue now on press.

☐ I prefer 2 yrs. at $4 (Saves me $2 compared with the 1-yr. rate)
☐ I prefer 3 yrs. at $5 (Saves me $4)
☐ I prefer 1 yr. at $3
☐ Bill me later ☐ Payment enclosed

Name _____

Address _____

City _____ Zone _____ State _____

ALSO ON SALE AT ALL NEWSSTANDS 25¢

FPE-2-49

IT'S NEW
IT'S VALUABLE
IT'S *FREE!*

...The Most Complete Full Color Guidebook on Decal Nameplates Ever Published

Manufacturers! Executives! Meyercord, world's largest producer of decalcomania, offers this brand-new "Mark-It" Manual on Decal Nameplates *free*. Twenty full-color pages. New Decal developments. New application techniques. Information vital to every business. This handy reference book shows how America's leading products are Decal-marked by Meyercord—to save time labor, material . . . to provide colorful brand recognition . . . permanent product identification with nameplates that *sell!*

The new "Mark-It" Manual shows hundreds of durable, washable Meyercord Decals. Nameplates, trademarks, instructions, charts, diagrams . . . all sizes, colors, designs. Application is simple at production line speeds on all basic product surfaces, curved or flat—on metal, glass, wood, china, plastics, leather, rubber, crinkle—even on poultry. Tells how and where leading manufacturers use Meyercord Decals, for lasting adhesion despite vibration, acid, fumes, hard use and wear.

Executives!

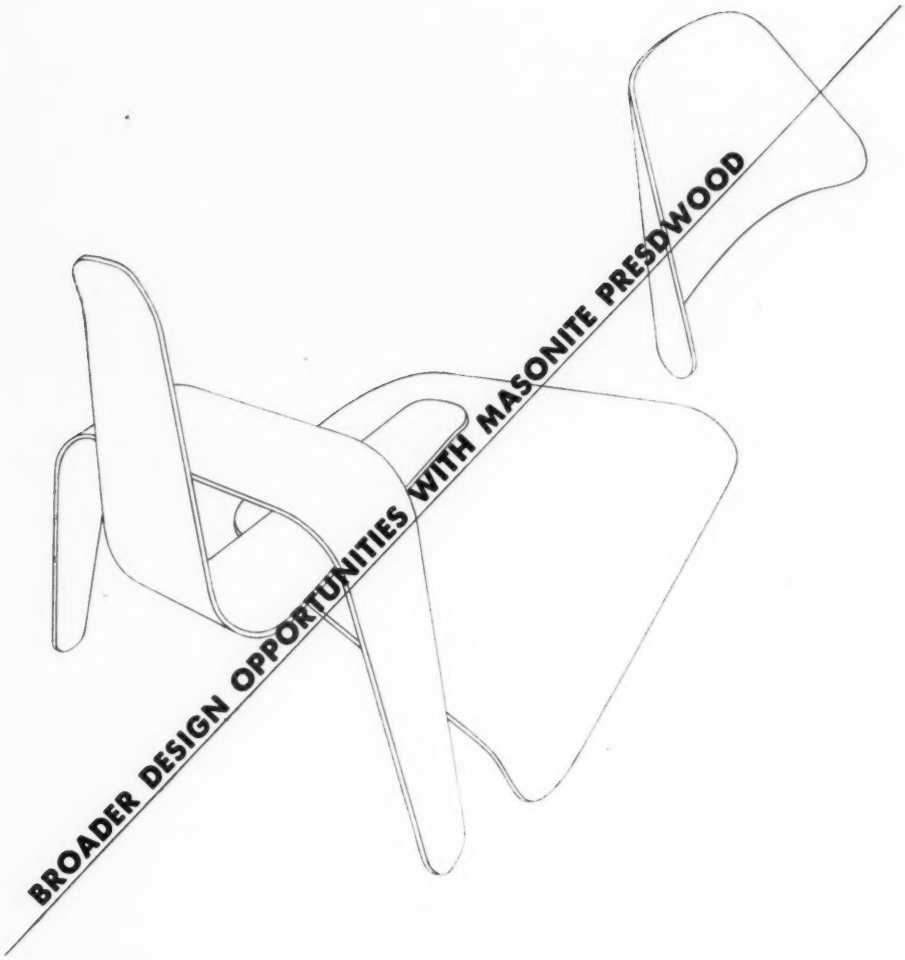
WRITE FOR YOUR COPY TODAY!

The new Meyercord "Mark-It" Manual on Decal Nameplates is available to all executives, FREE. No obligation. An invaluable handbook. To obtain your copy, simply write on your business letterhead. Please send inquiries to Dept. 16-2

Founder-Member Lithographic Technical Foundation

The MEYERCORD Co.
World's Largest Decal Manufacturer
5323 W. LAKE ST. CHICAGO 44, ILL.

ADVERTISE • IDENTIFY • DECORATE • WITH MEYERCORD DECALS



Many a good design idea winds up in the wastebasket because of *material limitations.*

But it's different when you work with Masonite Presdwood and Leatherwood. These time-proved hardboards combine more valuable characteristics with fewer limitations than *many other basic materials.* Presdwood is so versatile you can do almost anything with it.

Bend it? Yes—Presdwood can be bent in graceful curves.

Paint it? Yes—smooth Presdwood offers one of the finest surfaces known, not only for paint, but for virtually every other applied finish.

Work it? Yes—you can rout, die-cut, nail, screw, laminate and saw Presdwood with the greatest of ease. Easily worked with wood- or metal-working tools.

Presdwood is all-wood, made from exploded wood into hard, dense, grainless panels of tremendous strength and stability. It's permanently moisture-resistant, won't shrink, swell, split or splinter.

For over 20 years, Presdwood has been used to make better products and to make products better—everything from tiny toys to train interiors, from fine furniture to rugged truck bodies. You can use it profitably to solve many of your design problems. See our insert in Sweet's Product Design File.

MAIL THIS COUPON NOW!

MASONITE CORPORATION, Dept. PE-2
111 W. Washington St., Chicago 2, Ill.

Please send me, without cost or obligation, a sample of Presdwood and literature about how I can use it profitably as a product design material.

Name _____

Address _____

MASONITE REG. U. S. PAT. OFF.
PRESDWOOD *the best wood*

"Masonite" and "Presdwood" are registered trade-marks. "Masonite" signifies that Masonite Corporation is the source of the product.

"Believe it or not . . . this is my COMPLETE V-Belt Inventory"

"WE used to stock 124 different sizes of endless V-belts. Now, just four reels of Veelos, the link V-belt, give us every size we need. The right length belt for any drive is uncoupled from a reel, quickly made endless, then installed. Machine downtime for belt changeover is almost eliminated by the ease with which matched sets of any required length can be coupled on a drive. And by switching to Veelos, we've made a big saving on our V-belt investment."

You can do the same.

4 reels of Veelos provide as many as 316 sizes of endless V-Belts

Very likely you need less than 316 sizes for a complete V-belt inventory. When you stock Veelos on reels you can forget belt deterioration and obsolescence. Storage space is saved. Inventory records are simplified.

Veelos is made in all standard sizes . . . fits all standard grooves . . . is available in 100 foot reels. Sales engineers in principal cities; over 300 distributors throughout the country.

VEELOS
THE LINK
V-BELT

NEW VEELOS CATALOG

This is the catalog that brings many V-belt benefits to you. It gives you all the facts and complete engineering data. Your copy sent on request.

MANHEIM MANUFACTURING & BELTING COMPANY
MANHEIM, PENNSYLVANIA

VEELOS is known as VEELINK outside of the United States

ADJUSTABLE TO ANY LENGTH • ADAPTABLE TO ANY DRIVE

Gluttons for punishment

American
Heavy-Duty
Roller Bearings

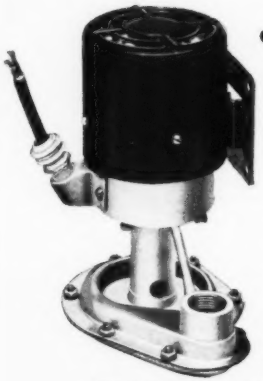
Designed especially for "tough going", AMERICANS have what it takes to render smooth, dependable service in heavy industrial applications. Strong, precision built, longer lasting, they will minimize your anti-friction bearing problems. Our technical staff will assist you in selecting the right bearings for your needs. Write.

AMERICAN ROLLER BEARINGS

AMERICAN
ROLLER BEARING CO.
420 Melwood Street Pittsburgh, Pa.

Pacific Coast Office: 1718 S. Flower St., Los Angeles, Calif.

Brady Pumps **FOR COOLANTS, AIR-CONDITIONING, REFRIGERATION**



- All-brass construction, rust proof, light weight, low cost. Heavy duty oversize motor, totally enclosed. Ball bearing, one-piece shaft.

Special pumps designed, engineered and manufactured to meet your requirements.

F. E. BRADY PRODUCTS, INC.
18TH AT EBRIGHT • MUNCIE, INDIANA

Solenoid
STAINLESS STEEL
Valves

ACTUAL SIZE

★ Standard pressure range, 5 to 250 psi
★ Dimensions 2¾" high x 1⅝" dia.
★ Impregnated coils withstand moisture and condensation
★ Soft insert seats prevent leakage
★ Spring loaded for positive action
★ Stainless steel parts highly resistant to corrosion and wear
★ Power consumption 10 watts max.
★ Pipe connections to specification
★ Also many special valves for handling pressures from 5 to 850 psi

THREE WAY - TWO POSITION
TWO WAY - NORMALLY CLOSED
TWO WAY - NORMALLY OPEN

Skinner will be pleased to make recommendations on your particular design applications — they have for hundreds of others. Write today for details and catalog.

SKINNER ELECTRIC VALVES

Skinner **ELECTRIC VALVE DIV.**
THE SKINNER CHUCK COMPANY
132 Belden Ave., Norwalk, Conn.

TWO ways you benefit from MB Isomode* Vibration-Isolators

1. IMPROVED VIBRATION CONTROL!

2. EASIER ENGINEERING!

Experiences of two well-known manufacturers demonstrate this double benefit:

Always on the alert to improve their product, a truck maker comprehensively tested Isomode mounts. Their adoption followed quickly. Because, instead of previous, typical truck characteristics, motors mounted on *Isomode* units displayed passenger-car performance! *Vibration was really isolated*, even though the units were not at optimum locations, but placed at standard points to allow interchangeability with earlier models.

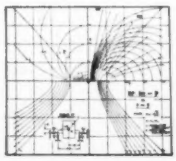
Another company, with a tough vibration control problem because they use various makes and types of engines in their own product, discovered *engineering and production simplicity* through Isomode units. Vibration was controlled by units placed at the regular mounting points. This accomplishment is all the more remarkable when you consider that the vibration varies with each type of engine!

There you have actual demonstrations of the value of Isomode units' outstanding advantage—"equal spring rates in all directions". The same benefits apply to *many* products—engines to electronic assemblies. And you not only isolate them more easily, but also gain a mounting that *withstands severe shocks!*

**Trade Mark Reg. U.S. Pat. Off.*

THE ADVANTAGES OF designing with ISOMODE MOUNTS

- ✓ *They absorb vibration in all directions* equally well—vertical, as well as troublesome horizontal and rocking motions.
- ✓ *Non-directional*—can be mounted at any angle, in any direction, simplifying design problems.
- ✓ *High load capacity* in compact size—saving space, weight, costs.
- ✓ *Large rubber volume* for softness—yet perfectly stable and self snubbing.

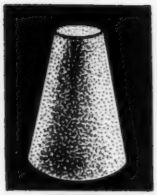


SEND FOR YOUR FREE COPY

This Isomode design chart saves you hours and effort—locates best points on your product at which to place standard mountings. For bulletin which contains chart and helpful information on vibration control, write Dept. F6

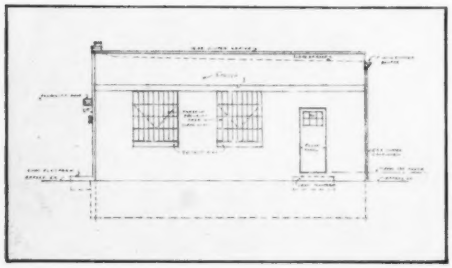
THE MB MANUFACTURING COMPANY, INC.
1060 State Street
New Haven 11, Conn.
VIBRATION ISOLATOR UNITS • VIBRATION TEST EQUIPMENT

VIBRATION DIVISION



with CONCRETE

— the small extra first cost of test samples pays off in assurance of efficiency and durability of the finished structure.



with TRACING CLOTH . . .

The small extra first cost of Arkwright Tracing Cloth, over that of tracing paper, repays many times over in the efficiency and durability of valuable drawings.

Arkwright gives both immediate *and* future advantages. The expert work of the draftsman is made permanent. Your investment in time and money is backed by sharp, clean reproductive quality. Under repeated use — or on file for subsequent need — Arkwright assures perfect drawing performance year after year.

For every drawing worth keeping for future use — use permanent Arkwright instead of perishable tracing paper. Send now for generous samples and prove this superiority. Sold by leading drawing material dealers everywhere. Arkwright Finishing Company, Providence, R. I.

The Big Six Reasons Why Arkwright Tracing Cloths Excel

1. Erasures re-ink without feathering.
2. Prints are always sharp and clean.
3. Tracings never discolor or go brittle.
4. No surface oils, soaps or waxes to dry out.
5. No pinholes or thick threads.
6. Mechanical processing creates permanent transparency.

ARKWRIGHT

TRACING CLOTHS

AMERICA'S STANDARD FOR OVER 25 YEARS

DARNER BUILT BY CUYAHOGA

White SEWING MACHINES Since 1876

Sewing Machine DARNER

Unusual coil springs and wire specialties, like the White Darner attachment illustrated, which is a big time and labor saver for millions of housewives, tailors and dressmakers, are part and parcel of the service offered by the Cuyahoga Spring Co.

Why not take advantage of Cuyahoga's complete production, engineering and designing facilities. Our experience is at your service.

DARNS

MENDS

EMBROIDERS

A SUBSIDIARY OF Barium

The CUYAHOGA SPRING Co.

10251 Berea Road • Cleveland 2, Ohio

CASH-ACME Type A-16 Pressure Reducing Valve

Write for your free copy of our new 1948 Catalog, giving full details about CASH-ACME Products, or ask your mill supply dealer for—

If your equipment requires uniform pressures to operate correctly, don't let it bother you. CASH-ACME manufactures all types of pressure control equipment from ¼" to 2" pipe sizes for water, air, oil, steam, gas and liquid service.

If one of our standard models doesn't do the job, we'll try and develop a special valve for you.

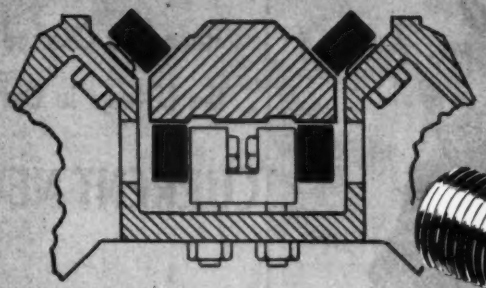
CASH-ACME *Automatic Valves*

A.W. CASH VALVE MANUFACTURING CORPORATION

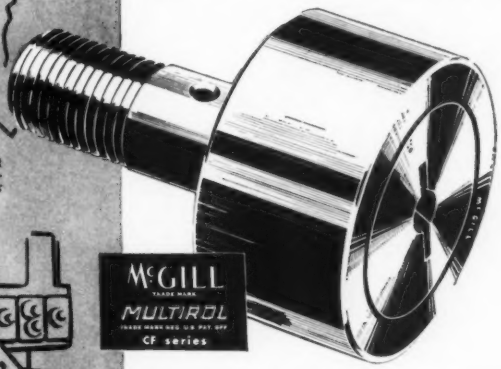
6662 EAST WABASH AVENUE, DECATUR, ILLINOIS, U. S. A.

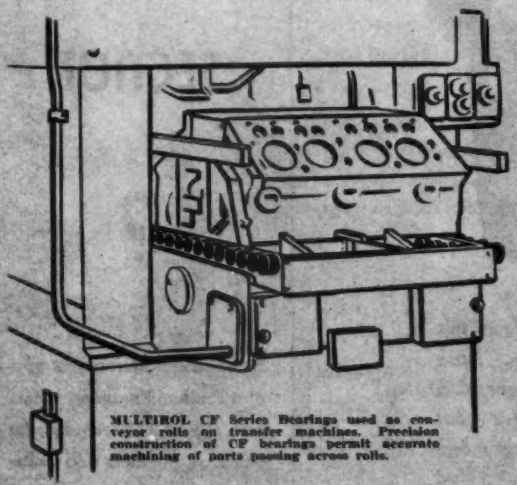
Increase Machine Efficiency *with . . .*

ANTI-FRICTION PERFORMANCE the *MULTIROL* way

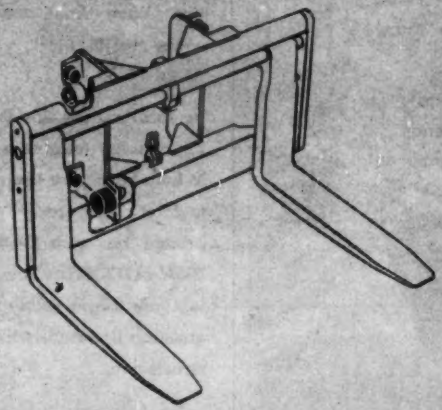


MULTIROL CF Series Bearings as support rollers for oscillating heads and tables on machine tools. Saves costly grinding and scraping of ways.





MULTIROL CF Series Bearings used as conveyor rolls on transfer machines. Precision construction of CF bearings permit accurate machining of parts passing across rolls.



MULTIROL CF Series Bearings as mast and platform guide rollers on lift trucks. Eases lifting and side adjustment of heavier loaded platforms.

When your design goal is the ulumate in anti-friction performance . . . when your specifications include heavier static and shock load capacity . . . then MULTIROL Cam Follower (CF series) bearings are what you've been looking for.

The Cam Follower is a rugged bearing. An extra heavy outer race section stands the repeated shock of cam operation. A full complement of small diameter rollers make up an almost unbroken steel ring which distributes the load evenly over a greater bearing surface. Internal wear and friction are held to the minimum, and power requirements of MULTIROL bearing equipped machines are appreciably lessened. CF bearings are easily lubricated through the stud or face of the bearing and sufficient lubrication is retained for adequate protection of those neglected applications.

MULTIROL Cam Follower bearings are precision built in a range of twenty-two standard roller diameters from ⅜" to 4". This wide variety eliminates the need for special cam follower specifications in most machine design.

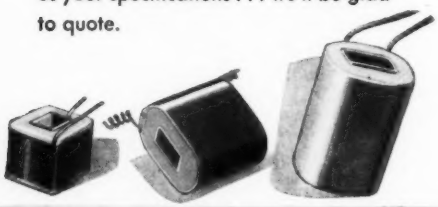
For dependable and long lasting anti-friction applications, at lower cost, investigate MULTIROL CF series bearings. Ask our engineers for their recommendations.

Write for Bulletin CF-40A. McGILL Manufacturing Company, Inc., 201 North Lafayette Street, Valparaiso, Indiana.

McGILL
TRADE MARK
precision bearings

We're proud of this record made by Coto-Coil windings. More than a million for one customer and only 476 turned down for imperfections, and this is not an isolated case. With the others it was made possible through finest equipment, skilled operatives and, best of all, engineering "Know how" and over 30 years of experience.

For dependable windings and dependable service, call on COTO-COIL. Send us your specifications . . . we'll be glad to quote.



COTO-COIL CO., INC.
COIL SPECIALISTS SINCE 1917
65 Pavilion Ave., Providence 5, R. I.

Have You Checked the Listings in Our

CURRENT NEW LITERATURE SECTION

?

Since resumption of this popular *Product Engineering* feature, almost 2,000 requests for catalogs, booklets and bulletins have been received every month.

Be sure you use this *Product Engineering* reader service to help keep your library up-to-date. The reply cards printed on each CURRENT NEW LITERATURE page are for your convenience in requesting literature which interests you.

Cut Polishing Time
Improve Surface Quality

with "LINDE" FINE ALUMINA POWDERS

Obtain superior finishes, free from microscopic pits and scratches, on metallic and non-metallic surfaces, in a fraction of the usual polishing time with LINDE Fine Alumina Powders. Less abrasive is needed, and it can be used directly from the container, eliminating levigation and other wasteful preparatory steps. They can also be compounded with waxes and used in stick form.

LINDE Fine Alumina Powders are characterized by ultra-fine, uniform particle size, high purity and hardness, and swift polishing action. They have already gained wide-spread acceptance in polishing materials ranging from metallographic specimens to gemstones and noble metals.

	Type A	Type B
Chemical Composition	Alpha Al_2O_3	Gamma Al_2O_3
Particle Size (approximate)	0.3 Microns	Less than 0.1 Microns
Hardness (Moh's) (Equivalent to crystalline material)	9	8
Crystalline Structure	Hexagonal	Cubic

LINDE Fine Alumina Powders may be the answer to your polishing problems. Call or write any LINDE office and we will be glad to discuss your particular polishing applications.

The term "Linde" is a trade-mark of The Linde Air Products Company

Linde
Trade-Mark

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 East 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

* Fluid Power Improves Production

"LOGAN"

AIR AND HYDRAULIC POWER-OPERATED CHUCKS

...WITH OPEN OR CLOSED CENTER

***FREE ENGINEERING SERVICE**

Our engineers will solve your chucking problems with Logan special chucks, mandrels and collet chucks. No obligation.

• 32 years' engineering know-how • Completely equipped plant • Satisfaction assured • Complete range of standard types • Extra factors of strength and durability • Accurate, dependable service

For your complete air and hydraulic chucking systems, Logan offers an extensive line of rotating cylinders, control valves, accessories, hydraulic power units and Collet Grip tube fittings.

Logan SAVES ★TIME ★EFFORT ★MOTION

Air and Hydraulic Equipment

LOGANSPORT MACHINE CO., INC. 812 Center Ave. Logansport, Indiana

CHUCKS • CYLINDERS • VALVES • PRESSES • SURE-FLOW COOLANT PUMPS

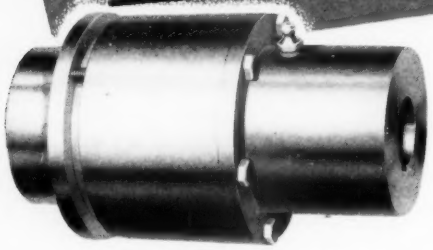
FREE CATALOGS

Write for catalog No 70, Section 1, on Logan air and hydraulic-operated chucks, catalogs Nos. 90 and 91 on air valves and cylinders

FLUID POWER SPECIALISTS SINCE 1916

WORRIED ABOUT CAPACITY?

SPECIFY A KINNEY Multi-disc Overrunning Clutch



The line of Kinney Clutches is complete — INTERCHANGE, OVERRUNNING, DRY PLATE, OIL TYPE AND WORRALL — for every service.

WITH the radically different Kinney Multi-disc Overrunning Clutch, capacity can be accurately determined—there's no guesswork in specifying the unit to exactly meet your load requirements. This new design eliminates the uncertain capacity of "cramp" type clutches which employ cams, rollers, or balls to handle both shifting and driving functions. In the Multi-disc, a separate, simple mechanism automatically shifts the clutch from full engagement to full release with positive and fatigue-proof reliability. The actual working load is carried by multiple friction discs of known capacity. This "two department" design gives two-fold safety—the Kinney Multi-disc gives instant pickup and carries the load with workhorse dependability. Capacities to 30 HP per 100 RPM—over 30 HP on special order.

Write today for information.

KINNEY MANUFACTURING COMPANY

3557 WASHINGTON STREET, BOSTON 30, MASSACHUSETTS

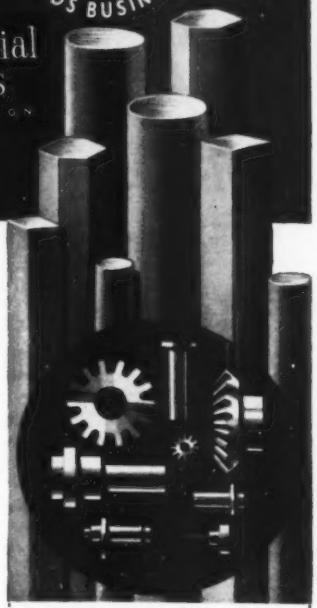
NEW YORK • CHICAGO • PHILADELPHIA • LOS ANGELES • SAN FRANCISCO

WE ALSO MANUFACTURE VACUUM PUMPS, LIQUID PUMPS AND BITUMINOUS DISTRIBUTORS

"BRAINS" of the leading Business Machines are made from J & L cold-finished JALCASE STEEL...

J&L STEEL

Monroe
Smith-Corona
National
CASH REGISTERS · ADDING MACHINES
ACCOUNTING MACHINES
IBM
Addressograph
FRIDEN
ALLEN WALES
SPEEDS THE UNDERWOOD WORLD'S BUSINESS
MARCHANT
R.C. Allen BUSINESS MACHINES
Multigraph
Commercial Controls CORPORATION
Remington Rand



...the original, free-machining, cold-finished open-hearth steel... for better quality precision parts at lower cost.

Look inside a business machine of any leading make, and most likely you'll be looking at a mass of precision parts accurately machined from J&L cold-finished *Jalcase* Steel. To the uninitiated, the "brains" of these modern marvels appear like an insolvable maze, but every tiny gear, lever and cam has a definite job to do—a definite function to perform for rigid accuracy.

There are some sound business reasons why so many of these working parts are made from J&L *Jalcase*—the *original*, free-cutting, open-hearth steel:

- **Jalcase is the leading free-cutting steel—and has been for more than 25 years.**
- **It machines smoothly and easily at high speeds.**
- **It lengthens tool life and reduces the number of stops for re-tooling.**
- **It is easily and quickly heat treated.**
- **It has high wear resistance.**
- **Ten grades plus a number of special treatments offer the Jalcase user a wide range of desirable properties.**

If you machine steel in the manufacture of your products—investigate *Jalcase!*

We have just published a new brochure on cold-finished *Jalcase*, and shall be glad to send a copy to anyone interested in machining rod and bar stock. The coupon at the right is for your convenience.

JONES & LAUGHLIN STEEL CORPORATION

Jones & Laughlin Steel Corporation
409 Jones & Laughlin Building
Pittsburgh 30, Pennsylvania

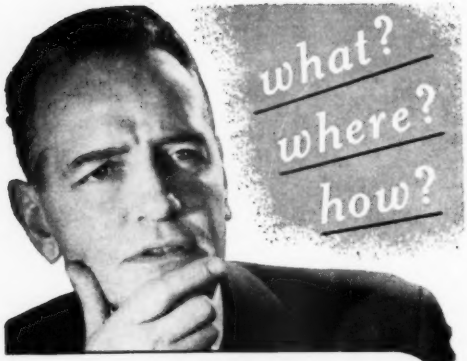
Please send me your new brochure describing J&L cold-finished *Jalcase*—the original free-cutting, open-hearth steel

NAME _____

ADDRESS _____

CITY _____ ZONE _____

STATE _____



maybe this Folder will give you the answer

• If the problem has to do with transmitting reciprocal action from one place to another, TRU-LAY Push-Pull very likely is the best answer. Read these highlight facts about TRU-LAY Push-Pull.

It . . .

. . . is as positive in action as a steel rod, yet flexible as wire rope

. . . will operate over long or short lengths, with few or numerous bends

. . . will operate while flexing

. . . is made in capacities up to 1000 pounds input

. . . is precision-made, assuring minimum backlash and long life

If you do not have a copy of this descriptive folder, write to our Detroit office

ACCO

6-235 General Motors Bldg., Detroit 2
1119 Santa Fe Avenue, Los Angeles 21 • Bridgeport, Conn.

AUTOMOTIVE AND AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

In Business for Your Safety

WRANGLING *is OUR specialty too!*

In fact, for nearly 50 years ESCO has successfully tackled special electrical problems the world over. Whatever you require in specially designed rotating electrical equipment — motors, converters, dynamotors, special DC, AC, and universal motors — ESCO knows the answer. Not only are our units engineered to meet your exact need, every unit that leaves ESCO is tested to guarantee satisfaction. Each and every unit is dynamically balanced and individually tested under load conditions. Do not hesitate to send us your problem. ESCO will provide applicable data without obligation.

Made to Order

ELECTRIC MOTORS • GENERATING PLANTS • GENERATORS
MOTOR GENERATING SETS • DYNAMOTORS • CONVERTERS

Electric Specialty Co. ESCO
170 SOUTH STREET, STAMFORD, CONN.

EARLE GEARS ARE BUILT FOR HEAVY DUTY

Earle Gears are plenty tough—can take hard usage, year after year. Take, for example, the job they are doing on the President Harry S. Truman Bridge in Missouri—or on the Oceanic Bridge in New Jersey.

For years, Earle Gears have proved their ability to give uninterrupted service with a minimum of maintenance on swing, vertical, rolling lift and bascule bridges as well as dams, gates and dredges.

The manner in which they stand up to heavy duty like this is indicative of the service they will give you. Send for our catalog. THE EARLE GEAR & MACHINE CO., 4707 Stenton Ave., Philadelphia 44, Pa. Sales Offices: 149 Broadway, New York 6; 901 Davis Ave., Pittsburgh 12, Pa; 7735 Market St., Youngstown, Ohio.

It's good business to do business with EARLE

EARLE GEARS

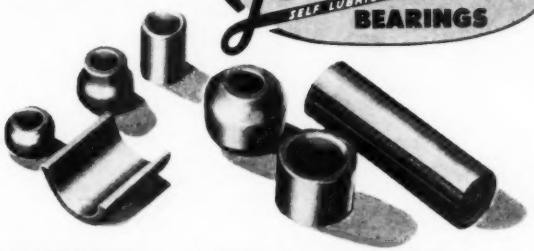
JOHNSON BRONZE

SLEEVE BEARING DATA

Ledaloyl SELF LUBRICATING BEARINGS

JOHNSON BRONZE

SLEEVE BEARING DATA

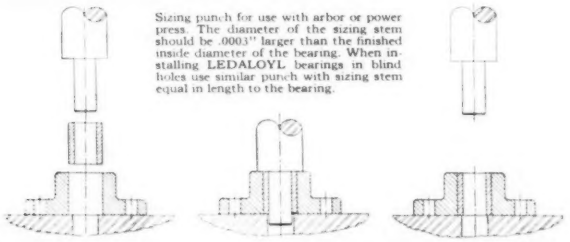


POWDER METALLURGY for Bearings and Parts

Powder Metallurgy is not a new manufacturing process . . . but its wide-spread adoption by industry is of comparatively recent origin. Bearings and parts, when produced by this method, are molded under pressure to required shape and size. This eliminates expensive machining operations and when quantities of a size are used the cost is surprisingly low. The original formula of the bronze powder consisted of approximately 88½ copper, 10 tin and 1½ graphite. In 1936, Johnson Bronze introduced LEDALOYL . . . a powder metallurgical product that conbined copper, tin, graphite and *LEAD* in the form of a PRE-ALLOYED bearing bronze. The introduction of lead as an integral part of the bronze powder provided additional bearing qualities not possible otherwise.

Manufacturers of many types of equipment gain many **extra** advantages through the use of Johnson LEDALOYL. One valuable feature is the self-lubricating action. Myriads of tiny, evenly spaced pores serve as miniature oil wells. When the bearing is in use the oil is metered to the shaft . . . when at rest, the oil is absorbed by these pores. This provides adequate lubrication at all times . . . preventing wear and in most cases eliminating the expense and bulk of other lubrication aids. Service records show long, troublefree operation on many types of installations.

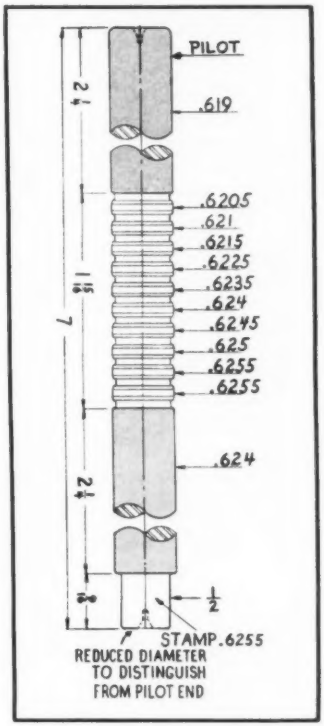
•



Sizing punch for use with arbor or power press. The diameter of the sizing stem should be .0003" larger than the finished inside diameter of the bearing. When installing LEDALOYL bearings in blind holes use similar punch with sizing stem equal in length to the bearing.

Method of Installations

LEDALOYL Bearings, correctly designed and properly installed, will usually outlast the motive unit in which they are used. We cannot place too much emphasis on installation. Absolute alignment is necessary in order to gain a low operating temperature, a short running-in period and a conservation of lubricant. The usual method of installing LEDALOYL is illustrated above. If your application is not covered in this way, we ask that you consult with our engineers. A method suitable to your application will be worked out. If your bearings are subject to excessive temperature during installation—such as in die cast applications—it is usually advisable to withhold impregnating the bearing until after assembly.



Typical Burnishing Tool

Harden, Grind and Lap, or Polish with Crocus Cloth High Speed Steel—Rockwell C-60-62.

Economy

The economy of using LEDALOYL is best illustrated in producing parts other than cylindrical in shape. Flat surfaces—flanges, offsets, etc. are easily provided for in the dies and no additional machining is necessary. Johnson engineers are always available to discuss the advisability of using LEDALOYL . . . or any other type of sleeve bearing in your product. Your inquiry carries no obligation.

•

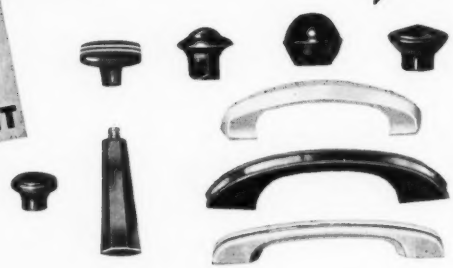
This bearing data sheet is but one of a series. You can get the complete set by writing to—

Johnson Bronze

SLEEVE BEARING HEADQUARTERS
508 S. MILL ST. • NEW CASTLE, PENNA.

FOR MOLDED PLASTICS OF *Beauty* AND *Economy*

YOUR BEST BET IS GRIGOLEIT



Stock Pulls, Knobs and Pendants

Here are but a few of the many stock pulls, knobs and pendants styled for sales . . . ready for immediate shipment. As always —in molded plastics your best bet is Grigoleit!

Write for colorful, fully-illustrated catalog.

THE GRIGOLEIT COMPANY
"Over Twenty Years in Plastics"
741 E. NORTH ST. DECATUR, ILLINOIS

Fast, Safe, Adaptable

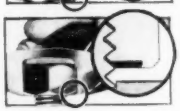
. . . the An-cor-lox lock nut

1. Spins on fast by hand. One piece. All metal. Available in high, standard, thin and acorn or cap designs.

2. Tightens just like an ordinary nut. Ideal for primary setup. Locking ring at base of nut, no extra stud length required.

3. Ring grips bolt with vibration and shock-proof grip. No axial play. Standard wrenches. Re-usable many times.

4. When backed off, locking ring *stays* locked! Prevents "walking off" even if other parts of assembly loosen.



Don't select your lock nut until you've tested An-cor-lox. Send today for descriptive literature and free standard samples.

An-cor-lox TRADE MARK REGISTERED *Lock Nuts*

LAMINATED SHIM CO., Inc., *An-cor-lox Division*, 1402 Union St., Glenbrook, Conn.

AN-COR-LOX NUTS • SHIMS • SHIM STOCK • STAMPINGS

Recent Developments in

PLASTICS and RUBBER

New materials and their characteristics, processes and techniques, and applications developed since the war are reviewed in a 32-page report which appeared in the April 1947 issue of *Product Engineering*.

This valuable reference for design engineers summarizes working data on

Polytetrafluoroethylene
Modified Styrenes
Polyethylene
Vinyl Plastics
Plastics-Synthetic Rubber Combinations
Synthetic Rubber
Nylon
Silicones
Cellulosic Plastics
Thermoplastic Laminates
Honeycomb-Sandwich Structures
Protective Coatings

Reprints in pamphlet form available at 25¢ each from

Readers' Service Department

PRODUCT ENGINEERING

330 West 42nd Street
New York 18, N. Y.

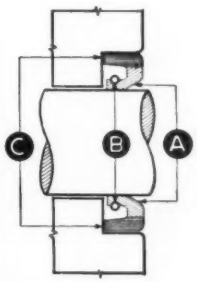
What—...AN OIL SEAL THAT'S Flexible?

TWIST IT . . . squeeze it . . . drop it . . . hammer it—the new one-piece concentric molded J-M Clipper Seal has plenty of give and take to help it stand up in service.

This flexibility has its advantages. The Clipper Seal's hard, tough outer heel, for example, is resilient enough to conform even to a slightly out of round cavity. Yet the soft, pliable *inner* lip always maintains a light, but positive sealing pressure on the shaft, with minimum wear on the seal.

The simple design of Clipper Seals also assures quick, easy installation, and permits removal without damage so that the seal may be used again. And because Clipper Seals are entirely non-metallic, they eliminate any possibility of electrolysis or corrosion.

Clipper Seals are made in both split and endless types . . . are available for shafts in sizes from ¼" I.D. up to 68" O.D. They are for sealing against oil, grease, water, coolants at operating temperatures up to 450°F. Write for folder PK-31A to Johns-Manville, Box 290, New York 16, N. Y.



Here's how *Clipper Seal* works:

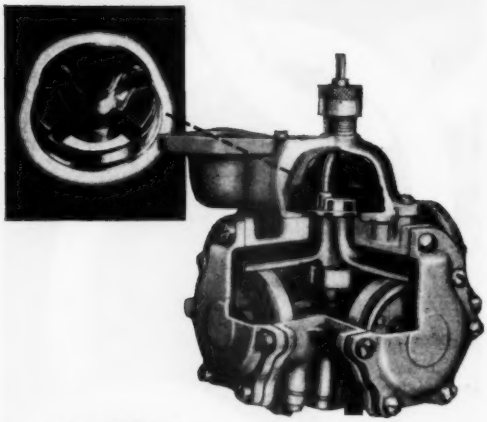
The lip (A) is held in light but firm contact with the shaft by means of a specially designed garter spring (B). Pressure on shaft is carefully pre-determined to minimize wear, yet effectively seal against leakage. The heel (C) provides a press fit in the cavity, assuring a tight lubricant-retaining seal at this point also. This design is readily varied to meet special conditions.

JM

Johns-Manville **PACKINGS & GASKETS**

PROBLEM:

To supply a rotary valve for gasoline meters that would slash normally high maintenance costs and eliminate inaccuracy in meter measurements.



SOLUTION:

Morganite developed and tested a self lubricating rotary valve suitable for gasoline metering. Tests indicated a 90% reduction in operating troubles due to friction, gumming or sticking.

MORGANITE
SELF-LUBRICATING
LIQUID METER VALVES

See our CATALOG in SWEET'S FILE for PRODUCT DESIGNERS

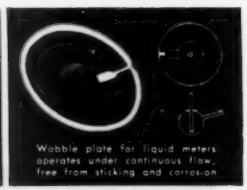
FOR DETAILED INFORMATION consult the Morganite Catalog in Sweets File for Product Designers; for engineering counsel or specific proposals call Morganite

Placed in actual service, results were even better than anticipated. Sticking and friction caused by wax and gumming deposits—the cause of inaccurate measurement and service failures—were reduced to the vanishing point. Morganite dry lubrication is effecting savings and solving "insoluble" problems in all phases of the mechanical, electrical and processing industries.

REGISTERED TRADE MARK **Morganite** INCORPORATED

LONG ISLAND CITY 1, NEW YORK

Self-lubricating valve for residential meters operates silently without metallic click or resonance.

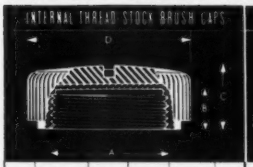


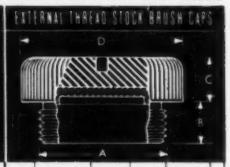
Wobble plate for liquid meters operates under continuous flow, free from sticking and corrosion

Manufacturers of Morganite Carbon Brushes for all motor and generator applications, and Morganite Carbon Piles.

STOCK SIZES

WRITE FOR PRICES AND SAMPLES
SPECIFY PART NO. AND SIZES





PART NUMBER	Thread Size "A"	Depth of Thread "B"	Height of Cap "C"	Diam. of Cap "D"	Screw Driver Slot
459	5/16"-32	1/8"	15/64"	1/2"	YES
441	3/8-27	5/32	19/64	9/16	YES
576	3/8-27	3/16	11/32	9/16	YES
682?	3/8-32	11/64	1/4	9/16	NO
662?	3/8-32	7/32	5/16	9/16	NO
442	7/16-27	5/32	5/16	43/64	YES
875	7/16-28	5/32	19/64	43/64	NO
721	7/16-32	7/32	19/64	43/64	NO
490	1/2-27	5/32	9/32	3/4	YES
528	9/16-27	3/16	11/32	13/16	YES
618	5/8-27	3/16	11/32	55/64	YES
663	11/16-27	3/16	11/32	1	YES
529	3/4-27	7/32	25/64	1	YES
780	13/16-27	3/16	5/16	1	YES
960	7/8-27	1/4	31/64	1-3/16	YES
530	15/16-27	15/64	7/16	1-1/4	YES
531	1-1/4-27	1/4	1/2	1-37/64	YES

PART NUMBER	Thread Size "A"	Length of Thread "B"	Height of Cap "C"	Diam. of Cap "D"
940	15/64"-40	13/64"	3/16"	13/32"
910	260-40	11/64	3/16	13/32
1000	9/32-32	5/32	3/16	13/32
920	5/16-24	3/16	15/64	1/2
970	5/16-32	5/32	15/64	1/2
900	3/8-24	11/32	3/16	9/16
990	3/8-27	5/32	3/16	17/32
870	3/8-27	3/16	3/16	17/32
890	3/8-32	3/16	3/16	17/32
980	3/8-32	3/16	3/16	17/32
880	7/16-27	3/16	3/16	9/16
820	31/64-32	1/4	1/4	21/32
395	1/2-24	1/4	9/32	3/4
850	1/2-24	9/32	3/16	21/32
930	9/16-27	3/8	1/4	13/16
700	5/8-27	13/64	1/4	13/16
940	5/8-32	3/16	1/4	13/16
581	5/8-32	13/64	1/4	13/16
830	5/8-32	3/8	1/4	13/16
840	3/4-24	5/16	5/16	31/32
494	7/8-27	7/32	1/4	1-3/16
723	15/16-24	19/64	5/16	1-3/16
673	15/16-27	7/32	7/32	1-3/8

ALL METAL THREAD BRUSH CAPS LAST CID HAVE SCREW DRIVER SLOTS

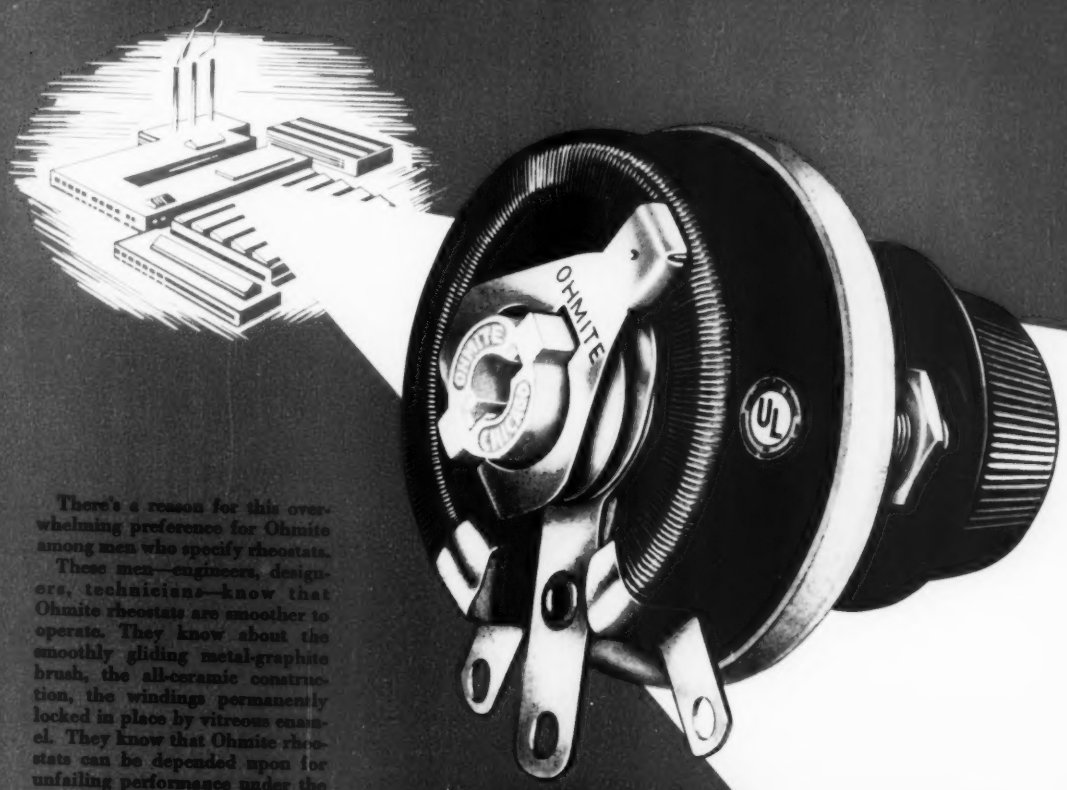
Some variations from listed dimensions can be made to order. Molded Black only. Metal inserts plated to specifications: Silver, Cadmium, Nickel. We also supply Customolded Brush Holders to fit; or both caps and holders can be made as you specify. Send us your requirements.

COMPRESSION AND INJECTION MOLDERS

Midwest Molding AND Manufacturing COMPANY

4630 FULLERTON • CHICAGO 39, ILLINOIS

Month after Month—More OHMITE Power Rheostats are Purchased than all other Makes Combined



There's a reason for this overwhelming preference for Ohmite among men who specify rheostats.

These men—engineers, designers, technicians—know that Ohmite rheostats are smoother to operate. They know about the smoothly gliding metal-graphite brush, the all-ceramic construction, the windings permanently locked in place by vitreous enamel. They know that Ohmite rheostats can be depended upon for unfailing performance under the toughest operating conditions.

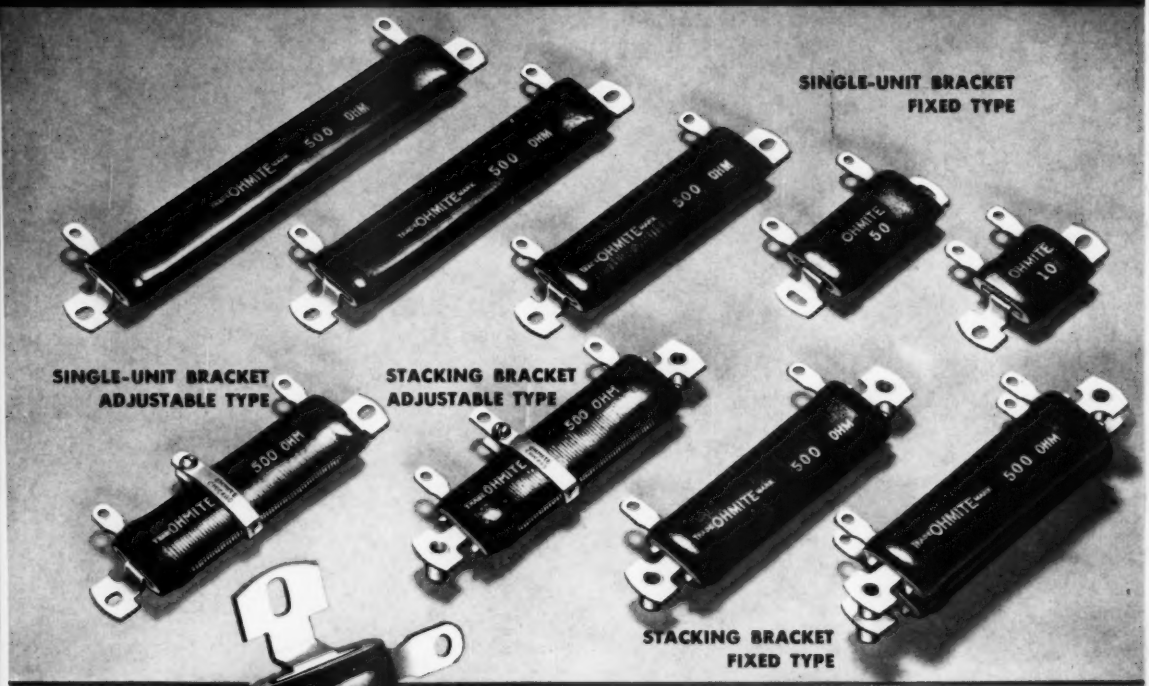
That's why Ohmite is first among industrial buyers . . . and why it will pay you to standardize on Ohmite rheostats for your product.

First Choice of Industry

Be Right with OHMITE

RHEOSTATS RESISTORS TAP SWITCHES

OHMITE THIN RESISTORS



VITREOUS-ENAMEL COVERING
Winding is rigidly held in place and protected from damage by Ohmite special vitreous enamel.

EVEN, UNIFORM WINDING
"Hot spots" and resultant failures are prevented by the resistance winding's unsurpassed uniformity.

STRONG, CERAMIC CORE
Unaffected by cold, heat, fumes, or high humidity, its core provides a strong base for winding.

FIVE WATTAGE SIZES
Lengths range from 1¼ inch to 6 inches, corresponding to ratings of 30 to 75 watts.

INTEGRAL MOUNTING BRACKETS
Distribute heat more evenly throughout resistor and conduct heat away quickly.

...PACK HIGHER WATTAGE INTO LESS SPACE

Because of their compact design, Ohmite Thin Type Resistors have a higher wattage rating per unit of space. They provide all the time-proven superiority of conventional Ohmite vitreous-enamel resistors—giving you a compact unit you can depend upon. Available in four types—all only ⅛ inch thick by 1 inch wide—in five lengths and a wide range of resistance values.

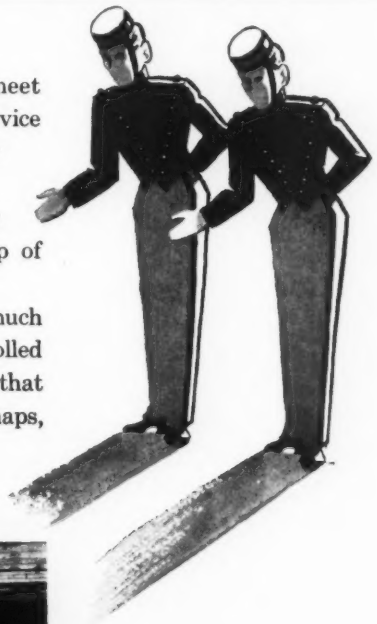
Send for Bulletin No. 138

OHMITE MANUFACTURING CO.
4819 W. Flournoy St., Chicago 44, Ill.

Be Right with

OHMITE
RHEOSTATS • RESISTORS • TAP SWITCHES

HE IS DOUBLY SERVED WHO GETS HIS STEEL, and GETS IT... when he wants it



International has helped many manufacturers meet their supply problems by providing dependable service in de-coiling, flattening, cutting, and pickling, or by coil slitting.

Here you will find such equipment as is used by the mills . . . the most modern, independent setup of this kind in the Midwest.

International — like everyone — has none too much steel. But, if you have available tonnages of hot rolled coil, International can process it for you on a basis that will assure a dependable, steady supply . . . and, perhaps, save you money. Ask about our service.

International's Flying Shear de-coils, flattens, cuts accurately to length. Coil slitter may be seen in background.

STEEL SERVICE INTERNATIONAL

International

ROLLING MILL PRODUCTS CORPORATION

5033 S. KEDZIE AVE., CHICAGO 32, ILL. Phone HE 4-5200

HANNIFIN

Standardized for

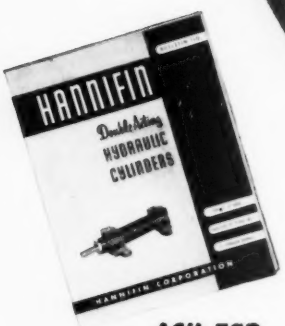
1. LOWER COSTS
2. QUICKER DELIVERY
3. SUPERIOR

Performance

ALMOST without exception, the hydraulic cylinder you need to fit even your special applications can be found as a standard unit listed in the big 52 page Hannifin catalog. This is your key to LOWER COSTS . . . QUICKER DELIVERY . . . SUPERIOR PERFORMANCE. The Hannifin line is complete! All standard and combination mounting styles . . . bore diameters, 1" to 8" . . . any length stroke . . . standard, double end, or heavy duty (2:1) piston rods . . . with or without cushions. Recommendations on request.

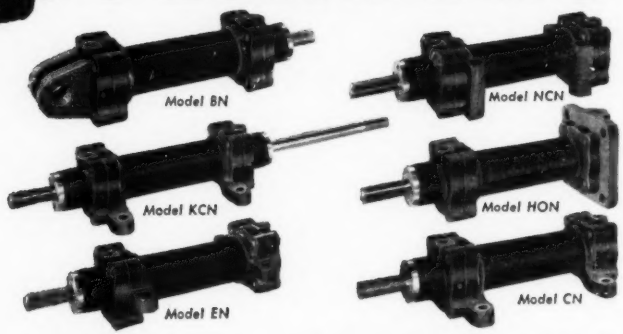
Model JN

HYDRAULIC CYLINDERS



ASK FOR THIS BULLETIN

■ Save time and money. Use this 52 page bulletin as a guide for meeting all of your hydraulic cylinder requirements out of a standard line. Complete specifications and data. Ask for Bulletin 110-O.

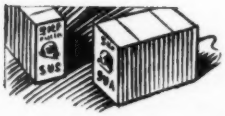


HANNIFIN CORPORATION

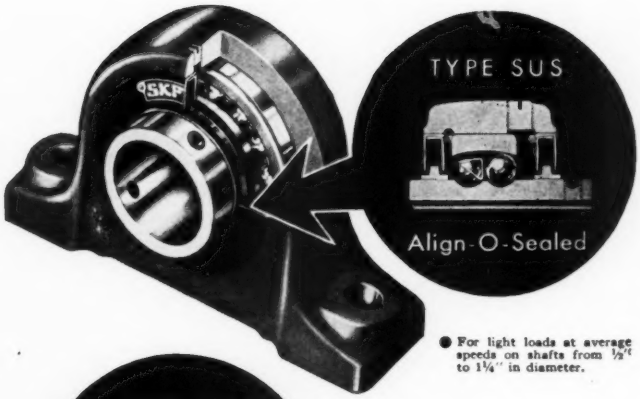
1101 S. Kilbourn Ave. HANNIFIN Chicago 24, Illinois

AIR CYLINDERS • HYDRAULIC CYLINDERS • HYDRAULIC PRESSES
PNEUMATIC PRESSES • HYDRAULIC RIVETERS • AIR CONTROL VALVES

Nationwide Sales and Service



Packaged READY TO GO!



● For light loads at average speeds on shafts from ½" to 1¼" in diameter.

● For shafts from 1 7/16" to 2 7/16" in diameter which are required to carry heavier loads than SUS units. Adapter mounting. TYPE SUAR — Same pillow block with spherical roller bearings.

Meet the youngest members of the SKF family of pillow blocks: SUS and SUA, both unit type pillow blocks. They come to you completely assembled, ready for quick installation.

Having self-aligning ball bearings, they automatically compensate for misalignment and shaft deflections without binding, insuring equal load distribution.

Their exclusive Align-O-Seals—with their close, leakproof fit—keep the bearings safe from lubricant leakage and the intrusion of dust, dirt and moisture.

SKF Bearings and their Pillow Blocks are manufactured under the closest precision control. When brought together, they fit like a glove.

6506

SKF INDUSTRIES, INC.
PHILADELPHIA 32, PA.

THE EXCLUSIVE SKF ALIGN-O-SEAL

A ring rotates with the shaft and within the U-shaped section of a circular cover. In the inside wall of the cover, facing the bearing, are evenly spaced holes which act as relief valves for excess grease. Overgreasing of the bearing is automatically relieved through these holes.

● *Send for Catalog 280, second edition.*

● *For replacement pillow blocks, consult your nearest Authorized SKF Distributor.*

SKF
PILLOW BLOCKS

NO WORRY ABOUT *Misalignment* WITH THIS DRIVE

It's an

S.S.WHITE FLEXIBLE SHAFT

The shaft is driving an oil pump on a large turret lathe. Power comes from the single pulley at the left which is adjustable for regulating belt tension. The short length of S.S.White flexible shafting supplies the required positive, steady drive which permits pulley adjustment and is unaffected by the resulting misalignment.

For drives in which one or both ends must be adjustable, there's no simpler answer than S.S.White flexible shafts. And even where both ends are fixed it pays to consider S.S.White flexible shafts, because they eliminate the need for precise alignment of connected spindles.

SEND FOR THE FLEXIBLE SHAFT HANDBOOK

260 pages of facts and technical data to help you select and apply flexible shafts. Copy sent free, if you ask for it on your business letterhead and mention your position.

S.S.WHITE INDUSTRIAL DIVISION

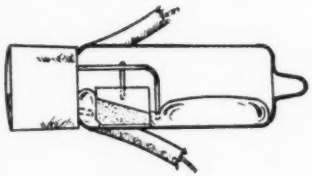
THE S. S. WHITE DENTAL MFG. CO. — DEPT. D, 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS AND ACCESSORIES
MOLDED PLASTICS PRODUCTS—MOLDED RESISTORS

One of America's AAAA Industrial Enterprises

POWREX MERCURY SWITCHES

Engineered for Durability



Long life and ease of operation make POWREX switches ideal for designed-in service.

Complete range of designs and sizes up to 30 amperes.

Available from Stock

MAIL THIS FORM TODAY!

POWREX SWITCH CO.
34 Pleasant St., Watertown 72, Mass.
Please send me without obligation your latest Bulletin M-19.

Name .....
Address .....
City ..... State.....
Position .....
Company .....

When your chance comes to step into a better job—
WILL YOU BE PREPARED?

These are times of change in business . . . Jobs must be filled quickly—with able men. These six volumes give you the practical knowledge that promotes executive efficiency—prepares you for a better job. They cover the methods of management most needed in the executive approach to business. Use them for immediate help on your present business problems—to get the "know-how" for the bigger jobs ahead.

THE McGRAW-HILL LIBRARY OF

BUSINESS MANAGEMENT

6 volumes, 1973 pages

1. BUSINESS ORGANIZATION: How to organize a department or business—plan and control its workings—provide personnel. **2. BUSINESS FINANCE:** Where and how to get money—the life blood of business. **3. CREDIT AND COLLECTIONS:** How to reduce credit losses—how to modernize your credit system—establish credit policy. **4. EFFECTIVE MARKETING:** How to improve sales methods—develop promotions. **5. BUSINESS CORRESPONDENCE:** How to write effective letters. **6. MANAGING YOURSELF:** How to conserve and direct your energies—how to handle detailed problems.

FREE TRIAL—EASY TERMS

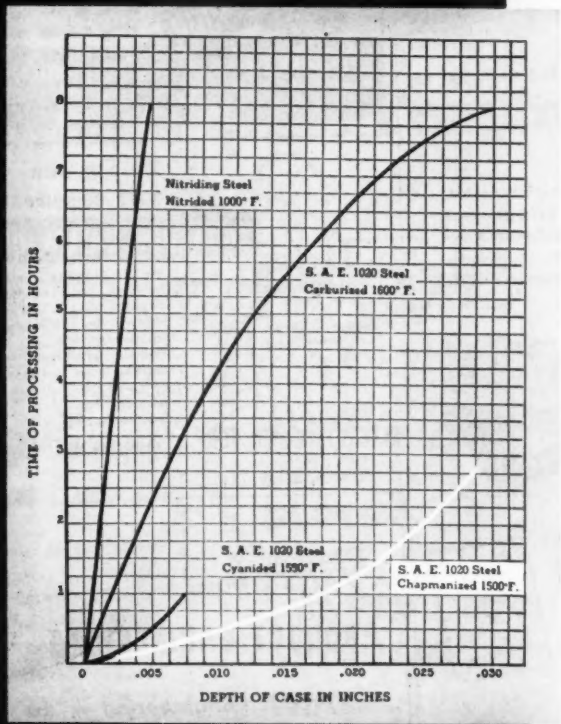
McGRAW-HILL BOOK CO., Inc.,
330 W. 42nd St., NYC 18

Send me the McGraw-Hill Library of Business Management, 6 volumes, for 10 days' examination on approval. In 10 days, I will send $2.50 and then $3.00 monthly until $17.50 is paid, or return the books postpaid.

Name .....
Address .....
City and State .....
Company .....
Position FPE-2-49

In only 1 *to* 4 *hours* *Chapmanizing*

Gives Free-Machining Steels Any Desired DEPTH OF CASE *from .002" to .035"*



So fast is Chapmanizing that any desired depth of case (from .002" to .035") can be produced on low-carbon steels in only 1 to 4 hours. And the case will be tough and ductile — free from chipping and checking. It will be silver-clean, too, requiring minimum finish grinding.

If you are interested in *faster surface-hardening* send us your parts today or let us send you the name of the nearest licensed Heat Treater. Or, if you prefer, we can hook a unit to your own pot-type furnace and you can Chapmanize right in your own plant.

Metallurgical Sales Division of

THE CHAPMAN VALVE MFG. CO.

INDIAN ORCHARD, MASSACHUSETTS

complete FOR SERVICE

consult

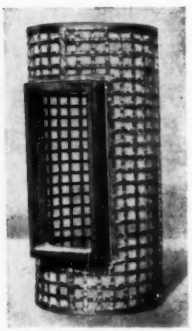
Cambridge

ON FABRICATED WIRE ASSEMBLIES FOR BULK HANDLING & PROCESSING

Woven wire slings reduce accidents — simplify bulk handling and shipping of pipes, tubes, shapes, etc.

Cambridge offers the engineering and fabricating facilities to supply you with baskets, trays, racks, crates or specialized fixtures in any metal or alloy . . . custom-built for your particular requirements.

Cambridge wire fabrications are "job-fitted" for all types of bulk handling and processing to insure maximum efficiency.



Representative crates, racks, slings and baskets fabricated by Cambridge for specific bulk handling problems.

For information on the complete Cambridge line, write for your FREE copy of this illustrated booklet! Consult your Cambridge Field Engineer on any individual problem.

There's a Cambridge Sales Engineering Office near you!

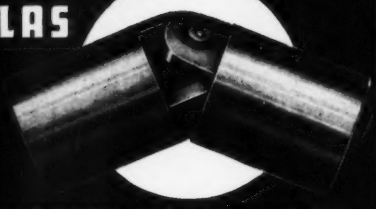
Cambridge Wire Cloth Co.

Wire cloth in rolls. | Any metal or alloy, mesh or weave

Department P
Cambridge 2, Md.

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

ATLAS



UNIVERSAL JOINTS

SAVE WEIGHT - SPACE - COST

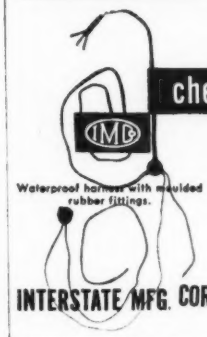
Short stubby jaws allow the Atlas to be used in applications where space is limited or where light weight is essential. Bearing loads held to absolute minimum by large bearings OF EQUAL SIZE located at maximum distance from center of joint. For full details write Dept. B

GRAY & PRIOR

Makers of Atlas and Vulcan Universal Joints

THE GRAY & PRIOR MACHINE CO., HARTFORD 5, CONN.

In the West: Link Belt Co., Los Angeles, San Francisco, Portland, Seattle, Oakland, Spokane



Waterproof harness with moulded rubber fittings.

We can wire your equipment

cheaper, better, quicker

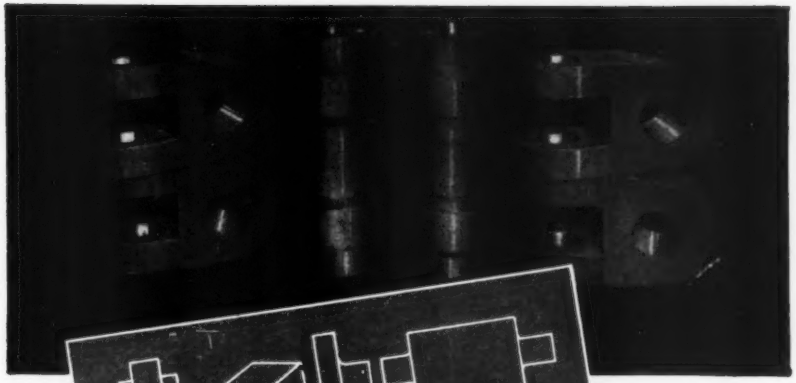
We furnish wiring systems and harnesses, engineered for your product; complete with all fittings; ready for low cost installation on the assembly line.
Harnesses of all types—wrapped, braided, laced, and armored, with plastic, ceramic and moulded rubber fittings.
Send for catalog.

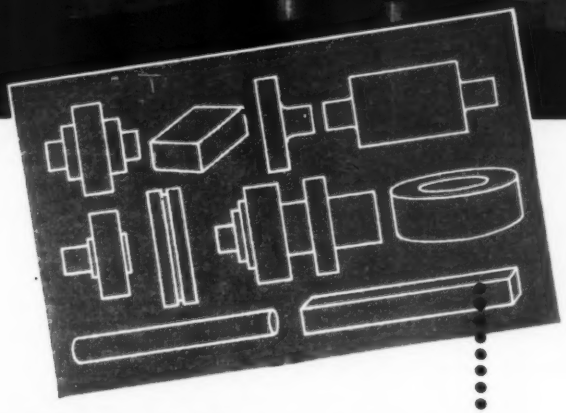
INTERSTATE MFG. CORP. 134 Sussex Ave., Newark, N. J.

Facts about

PRODUCT ENGINEERING

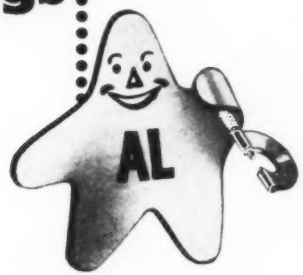
Product Engineering is the only paid-circulation magazine serving design engineers.





Stainless Steel Forgings

to Your Specifications



Rough Machining
Heat Treating

We can supply clean, top-quality stainless forgings either "as is," or rough machined, heat treated, etc.

Any Allegheny Ludlum field representative will gladly give you further particulars, or write us direct.

ADDRESS DEPT. PE-72

- **RINGS**
- **DISCS**
- **BLOCKS**
- **BARS**
- **SHAFTS**
- **SPINDLES**
- **HUBS**
- **SPECIAL SHAPES**

ALLEGHENY LUDLUM
STEEL CORPORATION
Pittsburgh, Pa.

Forging and Casting Division

DETROIT 20, MICHIGAN

AL

W&D 1700

PROVIDE METERED ACCURACY

in the Machines You Design and Build

MODEL 6-HDW-7-3
(non-reset)
Double Worm Gear for higher speeds up to 2000 revolutions per minute.

MODEL 5-SD-7-3
(non-reset)
Spur Gear End Drive for all light-duty rotary applications.

Before Each Machine Leaves Your Plant

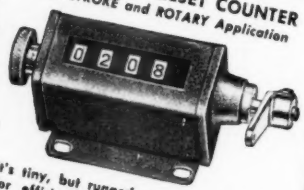
BE SURE IT CAN COUNT

Built-in Productimeters become a sales feature that appeals to plant engineers . . . they want the exact production control provided by Productimeters to maintain profitable operations under today's increased cost . . . they want the clear-cut machine settings provided by Productimeters for all set-up and other measuring functions — without the need for computation or interpolation.

There's a Productimeter for practically every industrial need—over 300 models to choose from.

New!

MODEL "Y" RESET COUNTER
for STROKE and ROTARY Application



It's tiny, but rugged . . . precision built for efficient operation at high speeds. Especially designed for built-in applications on all types of production and office machines.

Send for Catalog No. 100.

DURANT MANUFACTURING COMPANY

1938 N. Buffum Street
Milwaukee 1, Wisconsin

138 Orange Street
Providence 3, R. I.

Representatives in Principal Cities

PRODUCTIMETERS

SINCE 1879

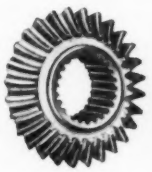
Speedometers of Industry

CUSTOM ENGINEERED

ROCKFORD CLUTCHES

We realize that your clutch needs may be "different". Seldom are two clutch problems exactly the same. So we build clutches to conform with your product's design. Our engineers specialize in clutch research and manufacturing developemnt. Their extensive experience in power transmission and control is at your disposal to find the *right* answer to your clutch problem. A print, showing your product's power transmission requirements, will command their careful study of the important factors involved and bring you their recommendations for giving your product the advantages of a custom-engineered ROCKFORD CLUTCH application.

ROCKFORD CLUTCH DIVISION
BORG-WARNER
209 Catherine Street, Rockford, Illinois



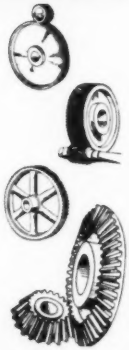
"ZEROL" GEARS

MADE FROM YOUR PRINTS OR ENGINEERED FOR YOUR REQUIREMENTS

In many applications, Zerol Gears made by "CAPITOL" are preferred to standard straight bevel gears. Because Zerols have curved teeth, they cut down certain stresses . . . provide greater strength . . . assure smooth quiet running . . . and increase gear life.

Many Zerol Gears made by "CAPITOL" on modern Gleason machines are being used on outboard motors and marine reverse gears. Sizes range from very small gears to large gears.

Perhaps you have a production problem right now that can best be solved by using Zerol Gears made by "CAPITOL". Why don't you send your prints to us for engineering recommendations and money saving quotation with prompt delivery.



All types of gears made. Send prints today.

AUTO ENGINE WORKS

337-P NORTH HAMLINE AVE. • ST. PAUL 4, MINN.

Design for user satisfaction...

...by designing a "built-in" lubricating system into your machine.

You assure your customer of uninterrupted production and cut down on your servicing costs when you design a Bijur system of automatic "metered" lubrication into your machines *at the time of manufacture.*

By concentrating all oiling points into one, this system *automatically* provides a controlled oil feed for all bearings regularly while the machine is running.

By thus eliminating the human element from the oiling routine, you do away with down-time for oiling, "forgotten" bearings, and a general feast and famine condition at the bearings.

Modern Design. Building the system into the machine at time of manufacture assures improved performance by coordinating lubrication and machine design, and produces a clean-lined machine with a minimum of projecting parts.

"Metered" Lubrication. Your machine will run more smoothly on Bijur-oiled bearings over a longer period of time. The system automatically controls the oil flow through a single-line distribution system to a series of meter-units, maintaining the correct oil film *at each individual bearing.*

When you consider the lubrication of that new machine, call on the Bijur engineer, or write for "The Travels of Modern Lubrication." This quarterly bulletin shows how leading machine manufacturers design "built-in" lubrication into their latest models.

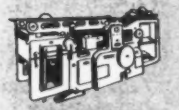
BIJUR

LUBRICATING CORPORATION

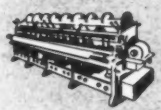
LONG ISLAND CITY 1 NEW YORK

Leading manufacturers who standardize on the Bijur system.

MACHINE TOOLS
Monarch "Lathe"



PRINTING PRESS
Miehle "Press"



TEXTILE MACHINERY
Whitin
"Knitting Machine"

PUNCH PRESSES
Bliss "Inclinable Press"

FOOD MACHINERY
Food Machinery "Filler"

Like these manufacturers, you too can "be sure with Bijur."

CUT FINISH COSTS ON THESE PARTS*

The quality, uniformity and dimensional accuracy found in Brass and Bronze Die Castings and Aluminum Bronze Permanent Mould Castings, make it possible to effect large savings by minimizing finishing operations in the manufacture of your parts. Reduction of set up time, the amount of stock to be removed and machining operations all contribute to cut costs. Then, too, there are instances where entire operations such as hobbing are eliminated. Polishing costs are substantially reduced due to smoothness of surface and elimination of sand holes. The constant dimensional accuracy and quality of these castings also make it possible to standardize production rates, eliminate rejects and in many cases cut assembly time.

Pressco maintains complete facilities for machining operations that might be required. Consult your nearby Pressco engineer or write for further information. Pressco representatives are located in all principal cities.

SAVINGS CAN BE EFFECTED ON RUNS AS SHORT AS A FEW THOUSAND

FABRICATED FOR

*The Heil Company
*Thompson Products, Inc.
*Minneapolis Mfg. Company
*McGill Mfg. Company, Inc.

PRESSCO

Largest Exclusive Manufacturers of Brass and Bronze Die Castings And Aluminum Bronze Permanent Mould Castings

CASTINGS & MFG. CORPORATION
CHESTERTON, INDIANA
Head Sales Office: 10 S. LaSalle St., Chicago 3, Illinois

Hartford PRECISION BALLS

CHROME ALLOY • STAINLESS STEEL
BRONZE • MONEL • K-MONEL • ALUMINUM
PLASTICS • COPPER • GLASS • DRILLED BALLS

Precision balls for every industrial requirement. Made in many different materials. Send your specifications for recommendations from our Engineering Department.

THE HARTFORD STEEL BALL CO.
HARTFORD, CONN.
NEWARK, N. J. OFFICE MARKET 2-7169 | EXPORT OFFICE: NEW YORK PHONE: PENNSYLVANIA 6-2078 | CHICAGO OFFICE FRANKLIN 1977

FORGINGS and STAMPINGS

DIXISTEEL forgings and stampings are made of carefully analyzed steel produced in our own open hearth furnaces. They are of highest quality and strength.

Send us your prints or specifications for forged or stamped parts, and we will be pleased to submit our estimate for production.

ATLANTIC STEEL COMPANY
P. O. BOX 1714 | DIXISTEEL | ATLANTA 1, GEORGIA

Capillary Tubing

ALL KINDS
ALL SHAPES

ROEHR PRODUCTS CO.
131 EAST 19TH STREET
NEW YORK CITY

This Thermo-Blo air cooling unit attaches to Linotype machines for the cooling of hot type molds. Manufactured by Mergenthaler Linotype Company, Brooklyn, N.Y.

SIMPLIFIES INSTALLATION

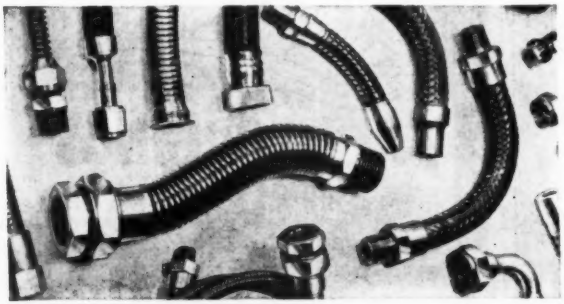
for this cooler of hot Linotype molds

The requirements indicated flexible metal hose: to carry up to 200 cubic feet of air a minute to hot Linotype molds . . . must be rugged, foolproof, quick to install . . . flexibility needed to counteract vibration, simplify alignment.

And American Flexible Metal Hose it was. For this particular application—the Mergenthaler Thermo-Blo air cooling unit for Linotype machines—American selected Type VAC Interlocked Flexible Steel Hose with asbestos-packed joints. The complete assembly is supplied with end fittings attached—designed by American from fitting to fitting at no extra cost.

SPECIAL DESIGN . . . NO CHARGE

Bring your connector problems to American. It doesn't matter whether they involve carrying water, steam, oil, other liquids, semi-solids, gases —or problems of misalignment, vibration, piping in cramped spaces, connecting moving parts. (You may even require a flexible connector of a special, rectangular shape.) An American flexible connector may be your answer. Remember, there's no charge for special design, and your connector can be furnished as a complete, ready to install assembly. Write for literature.



ANACONDA

American

METAL HOSE

THE AMERICAN BRASS COMPANY

American Metal Hose Branch

General Offices: Waterbury 88, Connecticut

Subsidiary of Anaconda Copper Mining Company

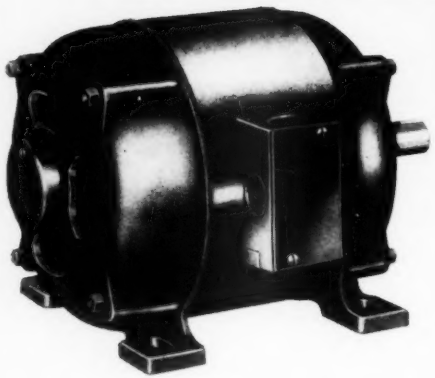
Distributed in Canada by:

THE CANADIAN-FAIRBANKS MORSE COMPANY, LIMITED

K-C

MOTORS

have proved their worthiness in many applications



Small motors by K-C have played an important part in furnishing compact, dependable power in a wide range of applications. Their selection by design engineers for in-built power is the result of universally satisfactory performance. Ample power, quietness, smooth, care-free operation have contributed to the better overall operation of the equipment they drive. Their attractive appearance has enhanced the value of motorized products of all kinds.

To specify 'K-C' is to be certain of efficient, economical machine operation.

Built in fractional horsepower ratings and in several integral ratings at higher speed.

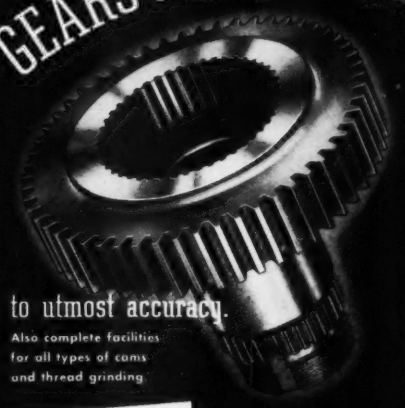
KINGSTON-CONLEY

Division of The Hoover Company

86 BROOK AVENUE

NORTH PLAINFIELD, N. J.

GEARS of every description..



to utmost accuracy.

Also complete facilities for all types of cams and thread grinding.

SPECIAL MACHINERY BUILT TO ORDER . . .

Large capacity devoted exclusively to the building of Machines, Assemblies and Parts for other concerns. Estimates furnished promptly upon receipt of prints or letter of inquiry. Bulletin E-200 lists our machine equipment.

HARTFORD *Special*

The HARTFORD SPECIAL MACHINERY Co., Hartford 5, Conn.

The very best facilities for

STAMPINGS

In Small Lots

DAYTON ROGERS

Manufacturing Company

Minneapolis (7), Minn.

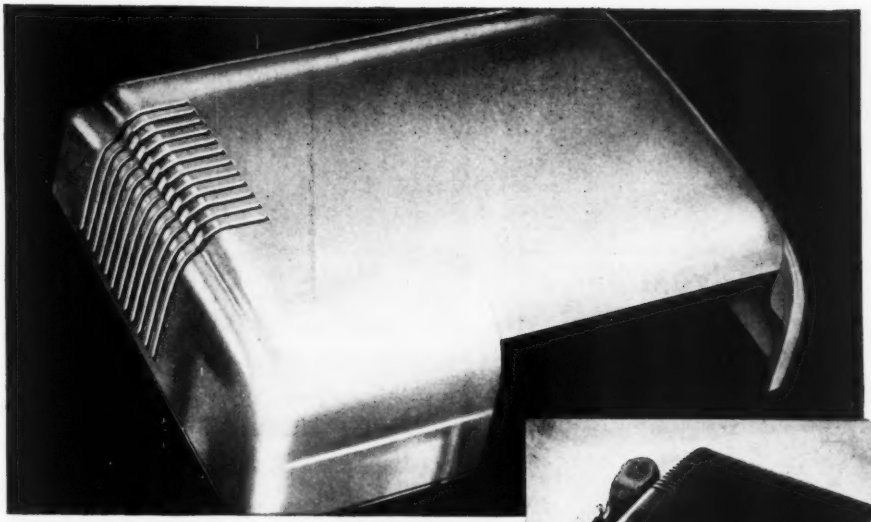
WILLIAMS

DROP-FORGINGS

ANY SHAPE · ANY MATERIAL · COMPLETE FACILITIES

Write for Free Forging Data Folder . . . Helpful, Informative

J. H. WILLIAMS & CO., "The Drop-Forging People" BUFFALO 7, N. Y.



The Dictaphone *Time-Master* dictating machine weighs only 20 pounds, can be carried about like a portable typewriter. One of the flexible plastic Memobelts on which it records is shown being inserted in the machine. The zinc base die casting, illustrated, forms the housing for the dictating machine as well as the transcriber (not shown).

Dictaphone Chooses

LOW COST—
HIGH STRENGTH—
LIGHT WEIGHT

ZINC BASE DIE CASTINGS

DICTAPHONE CORPORATION chose *metal*, rugged zinc base die castings to house the new Time-Master plastic belt dictating and transcribing machines. Castings for both machines are identical.

According to Dictaphone's Manager of Engineering, these are the major advantages of zinc base die castings for these housings:

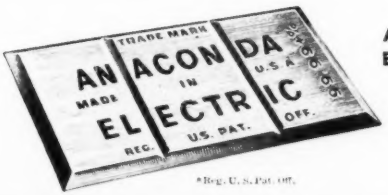
1. The ability of zinc base metal to be cast in very thin sections, for light weight.

2. Since the slots at the rear of the dictating and transcribing machines are different, they are formed by punching. Die cast zinc has the big advantage of being easy to punch. (Louvres at the side are part of the casting.)

3. Zinc is an acoustically dead and nonresonant metal and will not act as a sounding board for vibrations originating within the dictating machine.

4. The smooth, satiny surface that is an integral part of zinc base die castings needs little finishing. With proper treatment, it takes and holds applied finishes well.

Other characteristics of zinc base die castings are high strength, corrosion resistance, the virtual elimination of costly machining operations and the ease, speed and economy of forming intricate sections with fine detail and deep coring.



*Reg. U. S. Pat. Off.

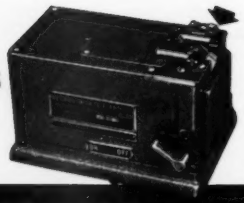
Anaconda does not make die castings, but sells Anaconda Electric* Zinc, 99.99+% Pure, to the Die Casting Industry.

ANACONDA SALES COMPANY

25 BROADWAY, NEW YORK 4, N. Y.
Subsidiary of Anaconda Copper Mining Co.

COPPER · ZINC · LEAD · SILVER · CADMIUM · BISMUTH · ARSENIC

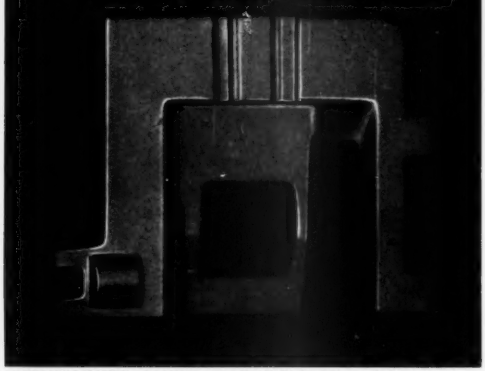
ON
WESTERN UNION'S
MULTIPLEX
TRANSMITTER



OHIO PRECISION

PLASTER MOLD CASTINGS

mean CLOSEST TOLERANCE
SMOOTH SURFACE • REAL ECONOMY



PHOTOGRAPHS COURTESY OF WESTERN UNION TELEGRAPH CO. AND J. H. BUNNELL & COMPANY

• When J. H. Bunnell & Company manufactured multiplex transmitters for the Western Union Telegraph Company, Ohio Precision made the pattern equipment for the plaster mold castings shown above. Since then Ohio Precision has regularly supplied these smooth, accurate, economical castings to Western Union contractors. Ohio Precision can save you time and money: 1. When you're waiting for dies and in a hurry for parts. 2. When quantities are too small to warrant expensive dies. 3. When sand castings won't meet specifications. 4. When machine production wastes metal. Solve product problems with Ohio Precision plaster mold castings!

OHIO PRECISION FEATURES

CLOSEST WORKING TOLERANCE
plus or minus .005 of an inch

NO MIS-MATCH TOLERANCE
Ohio Precision makes them match

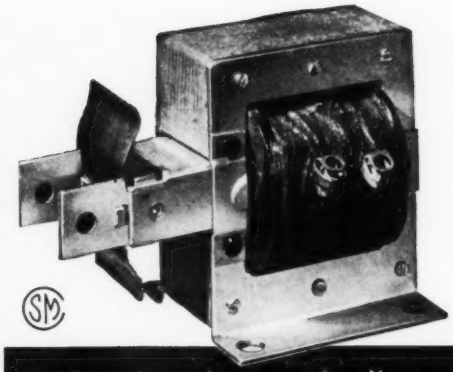
SMOOTH FINISH
minimizes costly machine work

MANY AVAILABLE SIZES
up to 8" wide, 10" long, 8" high

ADAPTABLE AND REASONABLE
saves expense of costly dies for experimental work

FOR COMPLETE COST FACTS, SEND PRINTS AND SPECIFICATIONS TODAY!

OPC
OHIO PRECISION CASTINGS, INC.
109 Webb St., DAYTON 3, OHIO
Plaster Mold Castings Made From Brass • Bronze • Aluminum • Beryllium Copper



Designed to give *your* Appliance Better Public Acceptance

No other solenoid like this one. It has shading coils in two places—an exclusive *patented* feature which makes this pull type, intermittent duty solenoid unbelievably quiet in the sealed position. Powerful, too—and available at attractive Soreng production line prices. Write for Circular N92.

SORENG Manufacturing Corporation
Main Plant - 1901 Clybourn Ave., - Chicago 14
Branch Plant - 231 Stone St., - Fremont, Ohio

Sier-Bath

GROUND or SHAVED Gears

for machines that keep their builder's promise!

• The accuracy of its gears has a great deal to do with reducing upkeep costs and increasing the life of a machine. Sier-Bath precision gears are made in a shop fully equipped with the finest machinery for shaving spiral and spur gears up to 24" diameter and for grinding spur gears to 16", spiral gears to 10", splined shafts (both straight side and involute) up to 42" long. Send us your specifications for quotation.

ALSO MFRS. OF SIER-BATH GEAREX & SCREW PUMPS
FOUNDED 1905 MEMBER A.G.M.A.

Sier-Bath
GEAR and PUMP CO., Inc.
9262 HUDSON BOULEVARD NORTH BERGEN, NEW JERSEY

You should know MORE about FULMER HONING MACHINES

Fulmer Model 412
⅛"-4" honing capacity

... to get high speed accuracy on finishing all types of cylindrical bores from ¼" to 30" diam. Fulmer Honing Machines remove stock **faster**, more **economically**, with **greater** accuracy, than **any other method**. Rugged in construction, simple to operate, Fulmer Honing Machines give maximum production with minimum investment.

★ **WRITE FOR NEW HONING BULLETIN, fully illustrated.** Gives valuable information on honing applications, **Alexander Ball** tools, and specification details on all models of Fulmer Honing Machines.

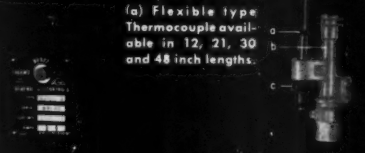
HONING TOOLS NOW AVAILABLE!

The **Alexander Ball** line of honing tools is now distributed exclusively in the United States by C. Allen Fulmer Co. Available in sizes from ½" to 50" diam. In many sizes of these tools, removable flanges are available in 1" or 3" increments of diameter. The same stone holders and basic tool are used. With **Alexander Ball** Tools the investment is very low where a wide range of diameters are honed. Write for complete details and prices.

C. ALLEN FULMER CO. 1237 First National Bank Bldg. CINCINNATI 2, OHIO

General Controls
A-100-5 THERMOPILOT RELAY

Provides automatic gas safety pilot control of the electrical circuit, operating solenoid valves and blower motors in heating units. Is manual reset, thermocouple type relay.



(a) Flexible type Thermocouple available in 12, 21, 30 and 48 inch lengths.

(b) 26 R (fixed type) Series Pilot Burner with flexible type Thermocouple used to insure exact position of Thermocouple in relation to pilot flame. (See Bulletin SDL 26 R-1 for complete data.)

(c) Compression fitting provided with Thermocouple for installing Thermocouple to 26 R (fixed type) Series Pilot Burner.

For complete specifications request Bulletin SDL 100 R-1

GENERAL CONTROLS
801 ALLEN AVENUE GLENDALE 1, CALIF.
Manufacturers of Automatic Pressure, Temperature & Flow Controls
FACTORY BRANCHES: BIRMINGHAM (3) • BOSTON (16) • CHICAGO (5) • DALLAS (2) DENVER (10) • DETROIT (8) • CLEVELAND (15) • HOUSTON (2) • KANSAS CITY (2) NEW YORK (17) • PHILADELPHIA (40) • PITTSBURGH (22) • SAN FRANCISCO (7) • SEATTLE (1)
DISTRIBUTORS IN PRINCIPAL CITIES
42-4

Janette

ROTARY CONVERTERS

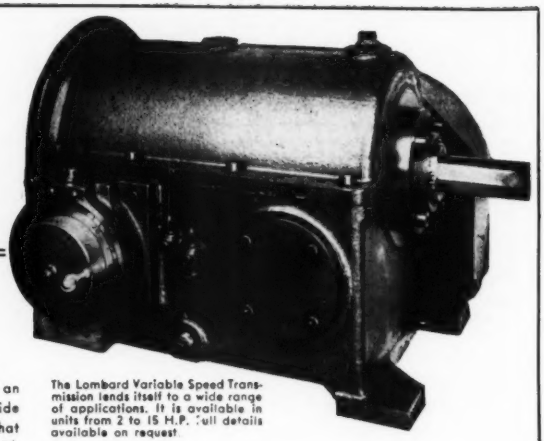
feature **SIMPLICITY** and **ECONOMY**

For over a quarter of a century Janette has designed and manufactured a wide range of dependable D. C. to A. C. converters to supply power for a great variety of electrically powered equipment. Specially designed filters are also available for applications demanding suppression of operating noise.

SEND FOR OUR BULLETIN 13-25

Janette MANUFACTURING COMPANY
556 W. Monroe St., Chicago 6, Ill.

THE NEW LOMBARD TRANSMISSION



. . . for applications requiring infinite variation in speeds

The Lombard Variable Speed Transmission lends itself to a wide range of applications. It is available in units from 2 to 15 H.P. Full details available on request.

By incorporating the Lombard Variable Speed Reducer as an integral part of equipment, it is possible to provide a wide range of easily controlled useful speeds. Design is such that a speed range of greater than 20 to 1 can be obtained with a minimum speed approximating zero.

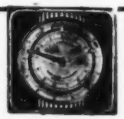
Power is transmitted in a straight line from input to output shafts, thereby assuring convenient application. A planetary speed reducing unit combined with the output shaft and mounted in a steel cage provides great rigidity and assures perfect alignment of gearing. All gears are enclosed and run in oil.

SEND FOR NEW CATALOGUE

LOMBARD GOVERNOR CORPORATION

Ashland, Massachusetts

EAGLE TIMERS for Controlling Industrial Processes



REPEAT CYCLE

Use where ON-OFF operation is continuously repeated. The ON time and OFF time are each adjustable on the dial. (FLEXOPULSE)

MICROMETER DIAL

Provides exceptional timing accuracy where a circuit is to close or open with a time delay. Timing adjustable over wide range.

(MICROFLEX TIMER)

COUNTER

Use for limiting a process to an exact number of operations. The counter contact opens after 1 to 400 electrical impulses as selected on dial. Automatic spring reset.

(MICROFLEX COUNTER)

MULTIPLE CIRCUIT —ADJUSTABLE

Use where several circuits are to close in a predetermined sequence. Time of closing and opening each circuit is adjustable.

(MULTIFLEX TIMER)

To reduce costs and improve quality of your products by automatic TIME-COUNT Control . . .

- ★ Write for catalogue Bul. 291.
- ★ Send for details of your control problems to Eagle for recommendations.
- ★ Consult Eagle representative in principal cities.

EAGLE Signal Corp.
MOLINE ILLINOIS

Production Designed for PROFITS!

Rubber and Asphalt floor tiles most efficiently die-cut on Hobbs Tri-Power Die Press.

For intricate or simple design forms in the cutting of cloth, rubber, paper, asbestos, plastics, etc., specify Hobbs Tri-Power Die Press. Write for Folder #30.

HOBBS MANUFACTURING CO.
Worcester 5, Mass.
EST. 1882

Help your shop stablize profits—Increase your own worth—by learning.

How to estimate the time any machining job will take

Here's the kind of on-the-job help you need to make quick, reliable estimates of the time it takes to do the different machining operations in any machine-shop—large or small. Whether a job involves drilling, boring, tapping, threading, grinding—or any of the scores of other operations—this handy manual tells you exactly what to consider in estimating job-time. It covers every step—from setting up the job, to tearing it down—giving reasonable time values for each, based on actual experience. The various non-machining operations which enter into the cost of any job are also given. Instructions are provided for the use of several methods of estimating specific jobs on each type of machine in use today.

Examine For 10 DAYS FREE

MACHINE-SHOP ESTIMATING

BY W. A. NORDHOFF

Douglas Aircraft Company

486 *pages*, 5¼x8¼, 486 *illustrations*, $6.00

This book sets down the principles of machine-shop estimating so clearly and concisely that you can put them to use immediately. It teaches you step-by-step how to estimate the time it takes to manufacture specific machined parts, classifying every fabrication job into matchining and handling operations. It supplies self-explanatory break-downs of all the elements of each operation and gives the time value established for each. These time values are usually presented in decimal minutes and are carried out to three places. In addition the book includes: sample estimates for each operation described, tables of variables and constants, and 93 typical problems to assist you in making your own estimates accurately and speedily. 486 illuminating charts, diagrams, tables and photographs are supplied to illustrate the topics discussed.

Tells you how to make estimates on such operations as:

—boring
—counterboring
—spot drilling
—facing
—slab milling
—straddle milling
—gang milling
—surface grinding
—countersinking
—center drilling
—reaming
—metal slitting
—screw slotting
—and scores of others

To see it 10 days FREE Mail Coupon

McGraw-Hill Book Co., Inc.
330 W. 42nd St., NYC 18
Send me Nordhoff's MACHINE-SHOP ESTIMATING for 10 days' examination on approval. In 10 days I will send $6.00, plus few cents postage, or return book postpaid. (Postage paid on cash orders.)

Name .....
Address .....
City and State .....
Company .....
Position ..... PPE 2-49

12 Richmond Street E., Toronto 1

NEW COUPLING by Boston Gear

"BE SURE YOUR NEXT COUPLINGS HAVE ALL THESE FEATURES..."

"Simple, accurately machined three-piece construction"
"Special oil-resistant synthetic rubber insert for quiet, flexible operation"
BOSTON
BOSTON
"Equipped with standard keyways and set screws"
"Available for shaft diameters from ⅜" to 1½"

BRAND NEW DESIGN . . . These new Boston Gear Couplings are designed for quick, simple installation and long, trouble-free service without attention. Completely, accurately machined, they are intended for a wide range of industrial applications where *flexibility*, *ruggedness* and *durability* are required. These couplings require no lubrication and are not harmed by oil, dust or dirt.

AVAILABLE IMMEDIATELY FROM STOCK! There's a Boston Gear Distributor within fast shipping time of your plant who can supply you with these new couplings. Write for complete list of authorized distributors — or see our alphabetical listing in THOMAS' REGISTER for your nearest distributor.

FREE! **Get this folder on Boston Gear's new flexible couplings**

Name ..... Position .....
Company .....
Address .....
City ..... Zone ... State .....

One of the world's most complete lines
71 distributors in major cities

BOSTON GEAR WORKS

83 Hayward St., Quincy 71, Mass.

AIR VALVES AND AIR VALVE SEATS

are made of toughest forgings —

NATIONAL DROP FORGINGS

The New York Air Brake Company makes outstanding compressors, known everywhere for remarkable service and efficiency.

Our forgings are used because they are skillfully made of steel of maximum toughness, strength and fatigue resistance.

National forgings have the requisite fibre-like grain structure reinforced at areas of greatest impact and wear.

Write us today for booklets describing our standard line of SAE yoke and rod ends, container handles and knife blades etc.:—and send us your inquiries for custom drop forgings.

The Trademark "N" is your guarantee of Fine Quality Forgings.

THE NATIONAL LOCK WASHER CO.

DROP FORGING DIVISION

NEWARK 5 **NEW JERSEY**

NEED A HIGH SPEED PUMP?

Install an **IMO**

The IMO Pump can be operated at motor and turbine speeds. It is ideal for direct connection and integral mounting. Excepting for the flow and vaporization characteristics of the fluid being pumped, there's practically no limit to the speed at which an IMO Pump can be operated.

IMO Pumps can be furnished for practically any capacity and pressure required for oil, hydraulic-control fluids and other liquids.

Send for Bulletin 1-147-C

IMO PUMP DIVISION of the
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY

GEARED FOR THE FUTURE

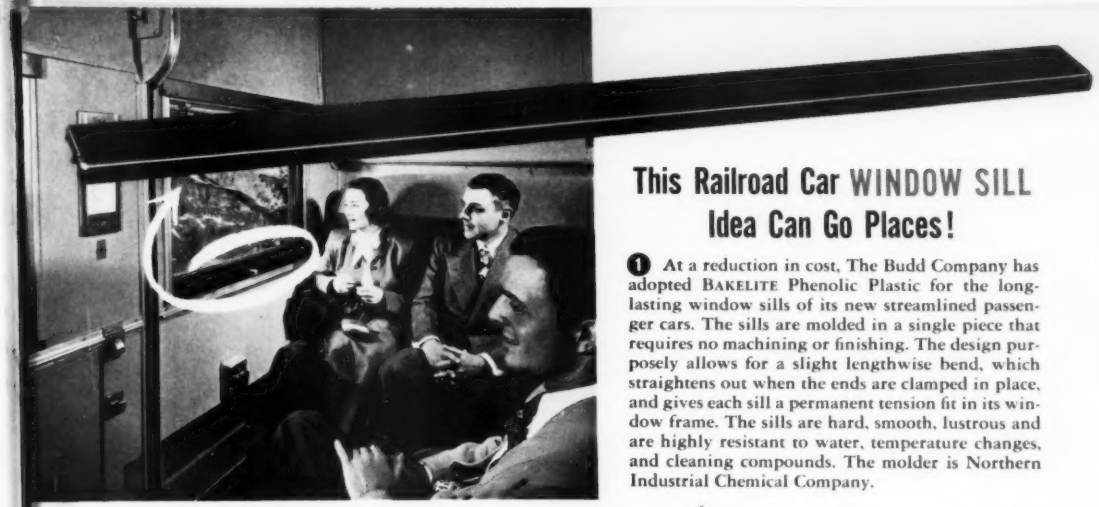
It has been DIEFENDORF policy through the years to build gears according to the specifications of the designers—the manufacturers who have created the machine of which the gear is just a part.

To keep faith with that manufacturer, DIEFENDORF GEARS are built for service into the future. Good design and construction from good materials.

DIEFENDORF GEAR CORPORATION

Syracuse 1, NEW YORK

DIEFENDORF GEARS

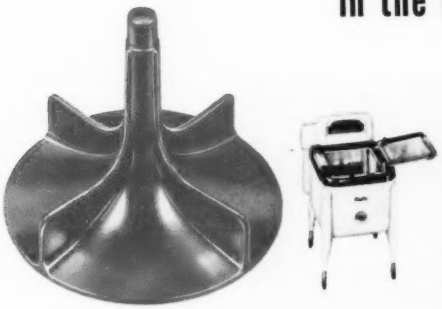


This Railroad Car WINDOW SILL Idea Can Go Places!

❶ At a reduction in cost, The Budd Company has adopted BAKELITE Phenolic Plastic for the long-lasting window sills of its new streamlined passenger cars. The sills are molded in a single piece that requires no machining or finishing. The design purposely allows for a slight lengthwise bend, which straightens out when the ends are clamped in place, and gives each sill a permanent tension fit in its window frame. The sills are hard, smooth, lustrous and are highly resistant to water, temperature changes, and cleaning compounds. The molder is Northern Industrial Chemical Company.

Opportunities for you

in the expanding family of Plastics!



BAKELITE NEWS

NO. 5

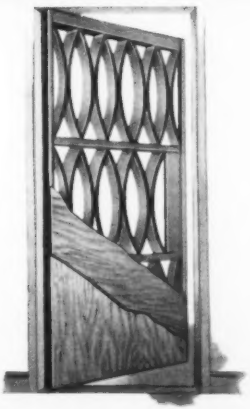
NOTES FROM BAKELITE CORPORATION ON BETTER, FASTER, LOWER COST PRODUCTION WITH "BAKELITE" PLASTICS

The SM-O-O-T-H-Y That Helps Safeguard Clothes!

❷ Agitators in the new Maytag Washers are made from a special type of BAKELITE Phenolic Plastic, bringing real benefits to manufacturer and housewife, alike. They're rapidly and inexpensively molded in a single operation to a degree of surface smoothness that is definitely kinder to fabrics. Light in weight, they are strong, attractively colored, and resistant to soap, detergents, hot water, and dirt. They're molded by the Plastics Division of General American Transportation Corporation, and by Chicago Molded Products Corporation.

What Can This DOOR Tell You About ADHESIVES?

❸ Bonded throughout with BAKELITE Urea Resin Glue BCU-12, this ingeniously designed flush-panel door made by Para Corporation is strong, light, good-looking and economically produced. It's another example of the growing trend to BCU-12 in the furniture, plywood and woodworking industries. For BCU-12 is highly extendible. It can be used for cold- or hot-pressing, curing rapidly at room temperature or up to 265 deg. F. A standardized product, it is suited to well-established gluing techniques.



LAMINATED PLASTICS Set This Idea Soaring!

❹ Helicopter blades built by Goodyear Aircraft Corporation now have an ingenious new covering on the aft two-thirds of their surfaces. It consists of "Formica" laminated plastics made with BAKELITE Phenolic Resin, pressure bonded between thin sheets of stainless steel. The laminate not only provides a high degree of weather resistance, but also adds stiffness, greater weight-lifting ability, and maximum resistance to distortion under load.

Does Your Product Call for a "COLD-WEATHER" PLASTIC?

❺ In short, does it need rigidity and good mechanical strength at the low temperatures found in refrigerators? BAKELITE Styrene Plastics furnish these qualities in the baffle assembly that separates the freezer compartment from the storage section of Kelvinator's new "Moistmaster" Refrigerators. Moreover, these "cold-weather" plastics are light in weight, dimensionally stable, resistant to moisture and to food chemicals—and they save money! The baffle shown is molded by the Plastics Division of General American Transportation Corporation.

Bakelite
TRADE-MARK
PLASTICS

BAKELITE CORPORATION

BAKELITE CORPORATION
Unit of Union Carbide and Carbon Corporation UCC
30 East 42nd Street, New York 17, N.Y.

Design Changes Are Easy with Versatile, Adaptable Plastics!

Check coupon below for information on specific subjects illustrated. For general information write for copy of Booklet G-8, "A Simplified Guide to BAKELITE and VINYLITE Plastics."

BAKELITE CORPORATION, Department 10
30 East 42nd Street, New York 17, N.Y.

Please send information on subjects checked below:

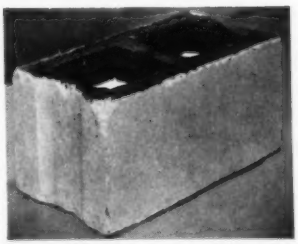
- ☐ 1. General-Purpose Phenolic Plastics
- ☐ 2. Impact-and-Chemical Resistant Phenolic Plastics
- ☐ 3. Urea Resin Glues
- ☐ 4. Phenolic Laminating Plastics
- ☐ 5. Molded Styrene Plastics
- ☐ 6. Polystyrene Emulsions

Your Name ..... Title .....

Your Company .....

Address ..... City ..... Zone ..... State .....

This Cement Block May Change Your Ideas About COATINGS



❻ There's something new in coatings that product designers, production managers, and maintenance men should investigate... **BAKELITE Polystyrene Emulsions.** The cement block illustrated tells the story. A test was devised in which only the *outside* surfaces of the block were given a single coat of Polystyrene emulsion paint. Then the block was filled with water for several months. The water traveled through the interior structure of the block, yet not a drop seeped through the coating... neither has the coating blistered nor peeled. These new BAKELITE Polystyrene Emulsions can be used straight or employed as a fortifying agent in standard types of water-thinned emulsion paints to improve gloss and washability. The exceptional "hiding power" of the new emulsions makes them serviceable for application on a variety of porous surfaces such as plaster, masonry, paper, cloth, wood and leather.

Metron

MINIATURE SPEED CHANGERS

★

COMPLETE
COMPACT
ADAPTABLE

- Over 500 different Standard ratios! 10:9 to 3375:1
- SMALL! 1.050" Diameter. Overall lengths: Type 5A, 3-3/16"; Type 5B, 4-1/32"; Type 5C, 4-13/16"
- Transmit power either way up to 230:1 ratios!
- Concentric ball-bearing input and output shafts.
- Hardened steel spur gears.
- Permanent lubrication.
- Prompt deliveries on production or experimental quantities.

BULLETIN No. 100

Gives complete details—Write for it today to METRON INSTRUMENT COMPANY, 444 Lincoln Street, Denver 9, Colorado.

BUILT BY Metron MAKERS OF INSTRUMENTS FOR PRECISION MEASUREMENT

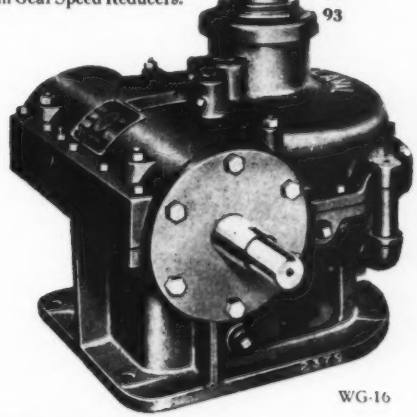
DE LAVAL VERTICAL DRIVE REDUCERS

A complete line of De Laval vertical speed reducers, in both single and double reductions, is available for driving agitators, mixers, and many other types of vertical shaft equipment.

If vertical drives are your problem, consult De Laval.

*This single reduction De Laval Worm Gear Reducer is available with many standard gear ratios and is but one of the 93 sizes and types of standard De Laval Worm Gear Speed Reducers.

*ONE OF 93



WG-16

Worm Gear Division

DE LAVAL

De Laval Steam Turbine Co., Trenton 2, N. J.

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS
CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

New! for

The new No. 418 Miniature Ball Bearing: ¼"o.d. ○ ⅛" bore. Available in both chrome steel and stainless.

Write for Catalog 49, gives complete data →

MPB MINIATURE *Precision* BEARINGS
INCORPORATED
KEENE, NEW HAMPSHIRE, U.S.A.

An Arwood Casting Saves 33%

The cam illustrated is a typical example of the advantages of precision casting. To manufacture it is a difficult problem in any process, since the track must be smooth, level and parallel with the top surface. Yet Arwood is casting this part in wear resistant beryllium copper at a cost one third less than a machined cam.

Precision casting is today a proven method for producing small intricate parts. Arwood, because of its vast experience with thousands of molds, is able to offer engineers these special features.

ACCURACY PLUS UNIFORMITY: Arwood has delivered dependable castings in trial runs of one hundred and production runs of a hundred thousand. Precision steel molds, designed and built by our own toolmakers, guarantee this accuracy and uniformity.

TOLERANCES: Close tolerances guaranteed ± .002 to ± .005 depending on alloy, size and shape.

VERSATILITY: A wide range of designs is possible so that engineers may consider performance instead of manufacturing convenience.

LOWER COSTS: Because machining is reduced to a minimum, savings up to 50% in small parts is not unusual.

Wide choice of metals.

Write for our booklet "Precision Casting for Engineers" or ask to have our nearest representative show you samples.

ARWOOD

PRECISION CASTING CORP.

68 WASHINGTON STREET • BROOKLYN 1, N. Y.

TOUREK BALL JOINTS and SCREW MACHINE PRODUCTS

1 BALL JOINTS

The use of Tourek Ball Joints has helped many manufacturers to improve product performance, simplify design and reduce costs. These benefits are yours too when you specify Tourek!.

Whether your specifications call for standard or special Ball Joints, you can depend upon Tourek performance, delivery and prices!

Send for your copy of Tourek's 16-page Ball Joint Catalog. It fully describes 12 standard types in 54 sizes carried in stock, and has data on special types as well.

2 SCREW MACHINE PRODUCTS

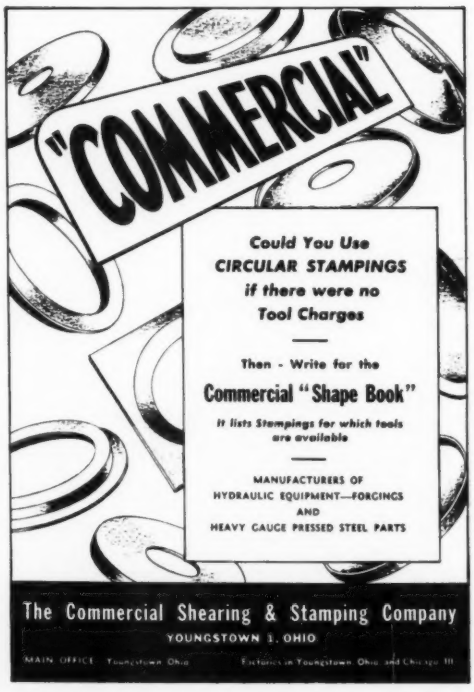
Tourek's modern plant—from the tool room to the batteries of giant 6-spindle automatics—is geared to turn out your screw machine product needs in any size up to 2⅜", from any type of metal. Twenty-eight years of production experience back up every job which Tourek undertakes.

For prompt quotation on your screw machine products requirements, simply send blueprint or sample.

MAKERS OF QUALITY SCREW MACHINE PRODUCTS

J. J. TOUREK MFG. CO.
4701 W. 16th St., Chicago 50, Ill.

ESTABLISHED 1920
TOUREK
FAMOUS BALL JOINTS



PUT A MERCURY CLUTCH ON THE JOB

A MERCURY CLUTCH is the engineer at the throttle...

... the brains of a power transmission system. A Mercury Automatic Clutch combines the smooth gentle application of power of a fluid coupling with the 100% efficiency of a mechanically locked-in power transmission.

A Mercury Automatic Clutch applies to the load only as much power (torque) as the prime mover is designed to produce... with no damage to the electric motor or wiring from overloading and no stalling of gasoline engines. It utilizes... *automatically*... the maximum torque production of the prime mover at its most efficient speed. With motors you get maximum torque at minimum current consumption.

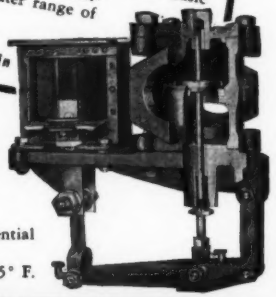
Consider a Mercury Automatic Clutch... for original equipment installations or wherever you use motors or gasoline engines in your plant. Write for information.

Mercury Clutch Division
ASP AUTOMATIC STEEL PRODUCTS INC. · CANTON 6 · OHIO

NEW—Direct Acting Solenoid Valve for 150 lbs. Differential Pressure . . .

That's the biggest news about the new Johnson Solenoid Valve. Some sizes will operate under differential pressures up to 150 lbs., *without pilot valves*. All sizes end the time lag and wiredrawing that come with slow opening—the danger of clogging that comes with auxiliary pistons. Whatever your liquid level or flow control problems, investigate the new possibilities this Johnson design brings to solenoid valves. It offers all the basic advantages, with none of the shortcomings, for a far greater range of applications.

GET ALL THE FACTS
Write for new bulletin



WHERE CAN YOU USE THIS AUTOMATIC VALVE?

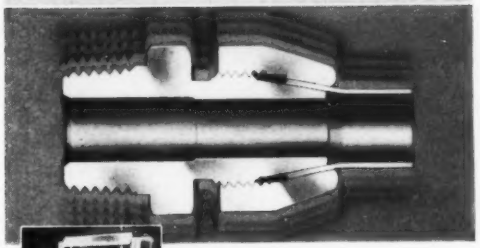
- Immediate full flow
- No pilot valves
- Up to 150 lbs. differential pressure
- Temperature to 365° F.

The Johnson Corporation
813 Wood St., Three Rivers, Mich.

Vibration under high pressure?

Superseal

Flared Tube Fittings make light wall tubing practical



Jaeger Mfg. Co. compressors have Superseal Fittings.

Would you switch to light wall tubing if you could obtain fittings that withstand vibration under high pressure?

Then you'll be interested in Superseal Flared Tube Fittings which are now standard equipment on steam generators and on air compressors with pressures running up to 600 P.S.I. The same fittings in an Underwriters' Laboratories test maintained a leakproof joint under pressures up to an amazing 8090 pounds, at which pressure the steel tubing split. Grinnell Company, Inc., Providence 1, R. I.

SUPERSEAL FEATURES SAVE TIME, SAVE MONEY!

PERMANENTLY LEAKPROOF JOINTS unaffected by vibration.

FOR ANY TUBING, including welded steel tubing, using a single flare.

LONG, SMOOTH, TAPERED 10° FLARE on fitting and inside of self-aligning nut hold tubing securely.

NO SHEARING ACTION to injure tubing at point of flare when nut is tightened. Tubing actually reinforced.

REPEATED DISCONNECTIONS without injury to tubing.

PRODUCTION FLARING up to 2000 a day on inexpensive flaring machine.

STOCKED IN BRASS AND STEEL, ⅛" to ½".

99 YEARS PIPING

GRINNELL

STEWART-WARNER CORPORATION

EXECUTIVE OFFICES
1826 DIVERSEY PARKWAY
CHICAGO 14, U. S. A.
LAKEVIEW 6000

MANUFACTURERS OF
"ALEMITE" LUBRICATION EQUIPMENT, LUBRICANTS & OILS
★
"SOUTH WIND" HEATING EQUIPMENT
★
"BASSICK" CASTERS, HARDWARE & TRIMMINGS
★
"STEWART-WARNER" SPEEDOMETERS, TACHOMETERS, INSTRUMENTS & ACCESSORIES
★
RADIOS
★
DIE-CASTINGS

SUBSIDIARY CORPORATIONS
ALEMITE CORPORATION
CHICAGO, ILLINOIS
★
THE BASSICK COMPANY
BRIDGEPORT, CONNECTICUT
WINSTON SALEM, N.C.
★
STEWART-WARNER-ALEMITE CORP. OF CANADA, LTD
BELLEVILLE, ONTARIO, CANADA
★
THE ALEMITE CO. OF NO. CAL.
SAN FRANCISCO, CAL.

October 18, 1948.

Mr. A. Hauptli, Jr.
Publisher
Product Engineering,
330 West 42nd St.,
New York 18, N. Y.

Dear Mr. Hauptli:

In answer to your letter dated October 12, wish to say that your publication is circularized among our Engineering personnel; and, insofar as my personal interest in the advertising is concerned, I find it to be of great value in keeping me up to date with new developments.

Yours very truly,

STEWART-WARNER CORPORATION,

D. C. Peterson,
Director of Engineering.

EB

PRODUCT ENGINEERS everywhere

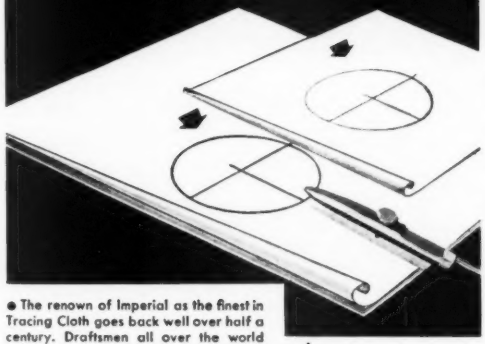
find

PRODUCT ENGINEERING

advertisements

of great practical value

TRACING CLOTH THAT DEFIES TIME



● The renown of Imperial as the finest in Tracing Cloth goes back well over half a century. Draftsmen all over the world prefer it for the uniformity of its high transparency and ink-taking surface and the superb quality of its cloth foundation.

Imperial takes erasures readily, without damage. It gives sharp contrasting prints of even the finest lines. Drawings made on Imperial over fifty years ago are still as good as ever, neither brittle nor opaque.

If you like a duller surface, for clear, hard pencil lines, try Imperial Pencil Tracing Cloth. It is good for ink as well.

IMPERIAL TRACING CLOTH

SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE

Specify UNI·FORM Stainless Moulding FOR LOWER TRIM COSTS

UNI·FORM* mouldings, made only by Greene of Racine, are produced on one-piece rolls, not by laminated section rolls. Result—all dimensional variations are eliminated, giving you these economies . . .

Faster Application
No need to adjust jigs and fixtures from lot to lot.

Lower Scrap Rate
UNI·FORM always fits. No jamming or pounding. No tag-end lots.

Simplified Handling
No receiving or storage problems . . . no need to segregate shipments.

Lower Inventory
Re-order anytime . . . get identical shape and exact dimensions specified

WRITE TODAY FOR FREE CATALOG (showing all standard sections actual size)

*Trademark

Greene Manufacturing Company Inc.
1028 Douglas Avenue RACINE, WISCONSIN

In THERMODRAFT "THE ELEMENT NEVER FORGETS!" It's Chace Bimetal!

No. 24—Product of the HOTSTREAM HEATER COMPANY Cleveland, Ohio

In the Thermodraft, manufactured by Hotstream Heater Company, Cleveland, Ohio, the use of a Chace Bimetal coil solves a common heating problem through automatic control. Chief cause of trouble on hand fired heating units is the human element. Manually opened drafts are forgotten, causing uncomfortable, unsafe, uneconomical overheating. Thermodraft replaces the human element with an element of thermostatic bimetal—and, "The element never forgets"!

Fixed end (A) of bimetal coil is fastened to control knob (B), the actuating end (C) to damper shaft (D). Control knob is adjusted to desired position between LOW and HIGH, opening damper as indicated by numerals. Since one end is fixed in position by control knob, higher temperature rotates actuating end of coil, turning damper to closed position, reducing combustion. With temperature drop bimetal reacts, reversing rotation of damper shaft to reopen damper. Continuous repetition of this cycle assures automatically controlled heat.

Chace Thermostatic Bimetal as the actuating element for heat responsive devices is available in strips or finished pieces. Consult the W. M. Chace Company engineering department for recommendations.

W. M. CHACE CO.
Manufacturers of Thermostatic Bimetals
1607 BEARD AVE. • DETROIT 9, MICH.

Now Ready

DIALCO

The

NEW HANDBOOK

. . . 192 PAGES of
USEFUL INFORMATION

Engineers, designers, purchasing agents —

GET YOUR COPY

You will find complete data on the lamps used in pilot lights.

And illustrations — all full size — of hundreds of items you will use.

There is a table of resistors for operation of lamps on all voltages.

Complete dimensional data on each unit.

More than 2,000 Underwriters' Listed Pilot Light Assemblies.

The DIAL LIGHT COMPANY of AMERICA

Foremost Manufacturer of Pilot Lights

900 BROADWAY, NEW YORK 3, N. Y.
TELEPHONE SPRING 7-1300

Visit Us at Booth 46 at the I.R.E. Nat'l. Conv.

Write for Handbook G-149

Recent Developments in
PLASTICS and RUBBER

New materials and their characteristics, processes and techniques, and applications developed since the war are reviewed in a 32-page report which appeared in the April 1947 issue of *Product Engineering*.

This valuable reference for design engineers summarizes working data on

Polytetrafluoroethylene
Modified Styrenes
Polyethylene
Vinyl Plastics
Plastics-Synthetic Rubber Combinations
Synthetic Rubber
Nylon
Silicones
Cellulosic Plastics
Thermoplastic Laminates
Honeycomb-Sandwich Structures
Protective Coatings

Reprints in pamphlet form available at 25¢ each from

Readers' Service Department

PRODUCT ENGINEERING

330 West 42nd Street, New York 18, N. Y.

Positive Contact . . .

With Any Switching Action

HONEYWELL

MERCURY SWITCHES

Plus . . .

- EASE OF ACTUATION . . . balanced, and light in weight, Con-tac-tors operate with little energy.
- LONG LIFE . . . fewer moving parts, simplified assembly means dependable, economical operation.
- VARIETY OF TYPES . . . means wide range of applications, increased design opportunities.

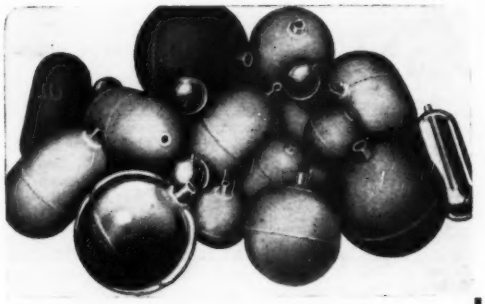
Honeywell Mercury Switches last longer, provide added safety because you always get a sharp, arc-free make or break with every switching cycle.

Mercury purer than all ordinary types and superior contact points sealed in vapor-proof tubes operate with an internal snap action. That means positive contact every time. No chance for "bouncing" contacts, fouled points or arcing.

Write today for Honeywell's Mercury Switch Catalog

MINNEAPOLIS-HONEYWELL REGULATOR CO.

2951 FOURTH AVENUE SOUTH • MINNEAPOLIS 8, MINNESOTA



Let Nicholson Solve Your Float Problems

Any Type. Stainless steel, Monel; chromium, cadmium or copper-plated steel. Prompt Delivery.

A pioneer in welded floats, Nicholson units are today standard with hundreds of manufacturers. In a new plant, advanced methods produce floats for a wide range of metal and buoyancy requirements; types for external and internal pressures. Sizes, 2" to 14" diam.; press. to 4800 lbs.; standard or special connections. 2-day delivery on many sizes and shapes. BULLETIN 348.

W. H. NICHOLSON & CO. 200 OREGON ST. WILKES-BARRE, PA.

in High Ambient Temperatures

This Welco Motor is designed to operate in continuous horse-power applications near the "motor killing" temperatures of baking ovens, boilers, and other sources of intense heat.

These special construction features assure a motor temperature rise no greater than 25° C.

- ★ **Big Rugged Turbine Type Fan**
- ★ **Extra Laminations of Finest Sheet Steel**
- ★ **Heavy Gage Wire**
- ★ **"Life-time" Sealed Bearings**

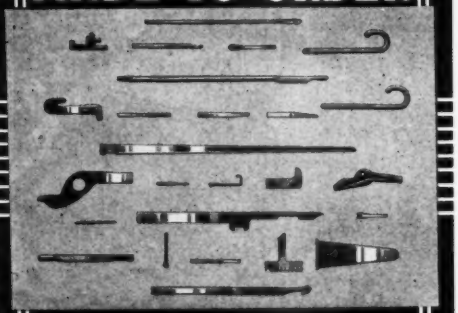
These open protected type ball bearing motors have unusually high efficiency and power factor. Available in all sizes to fit NEMA Frames between 203 and 365.

Write for full information.

THE B. A. WESCHE ELECTRIC CO.

1620 25 Vine Street Cincinnati, Ohio

MADE TO ORDER



For special flat metal or odd shaped parts as shown, we maintain a special department where such parts are built to your specifications.

Pressed and sheared to exact dimensions, with smooth edges. Odd shaped parts reproduced faithfully from sample or sketch.

Special equipment and 72 years of experience assure satisfaction.

The Torrington Company
SPECIALTY DEP'T.
Torrington, Conn., U.S.A.

Reprints Available!

EXPERIMENTAL STRESS ANALYSIS SYMPOSIUM

A 16-page insert, featuring histories of applications of experimental stress analysis methods which resulted in design improvements, appeared in the December 1946 issue of *Product Engineering*.

For those who would like copies of this insert for distribution among their technical staffs, a limited supply of reprints is available at 15c each.

PRODUCT ENGINEERING
330 WEST 42ND ST.
NEW YORK 18, N. Y.

PROFESSIONAL SERVICES

THE CARLSON COMPANY
Spring Design Specialists
MECHANICAL PRODUCT DEVELOPMENT
277 Broadway New York 7, N. Y.
Barclay 7-2552

YOUR card here builds prestige for you and helps to make your name familiar in the field. The cost is extremely small in proportion to its value as a business aid.

NEW YORK TESTING LABORATORIES, INC.
CHEMICAL, MECHANICAL, ELECTRICAL METALLURGICAL ENGINEERS ANALYTICAL CHEMISTS, PHYSICISTS, X-RAY
Analysis, Tests of all Materials and Products. Plant and Field Services in Special Measurements of Stress, Sound, Vibration and other. Consultants in Litigation and Process Engineering and Design.
80 Washington St. New York City 6, N. Y.

EGERTON DESIGN SERVICE
Mechanical Design • Drafting
Scheduled or Excess Drafting
617 State Street Traverse City, Mich.

GEORGE H. KENDALL
Consulting Mechanical Engineer
Cost Reduction Studies: Process or Product. Redesign Existing Products for Greater Profit. Trouble Shooting Production, Design, Cost Problems. Specialist Automatic Machinery, Processes, Controls. New Developments, Patent Studies, Investigations. New Products & Process Engineering Studies
P. O. Box 72 (Est. 1922) Tel. Darien 5-1504
Noroton Heights Darien, Connecticut

M. ROSENBLATT & SON
All Types Drafting & Design
Contract & Hourly Rates
111 Broadway New York 6, N. Y.
BEekman 3-7430

FAVREX DESIGNS
Mechanical drafting, machine tool design, tooling, special machinery, new apparatus, large technical staff will handle complete development from simple idea to detailed drawings.
Offices: Paris-France and Hasbrouck Heights, N. J.
536 Burton Avenue, Hasbrouck Heights, N. J.

LANCASTER ALLWINE & ROMMEL
REGISTERED PATENT ATTORNEYS
Patent Practice before U. S. Patent Office. Validity and Infringement Investigations and Opinions. Booklet and form "Evidence of Conception" forwarded upon request.
Suite 461, 815-15th St. N.W., Washington 5, D. C.

TECH-DRAFTING SERVICE CO.
DESIGNERS DRAFTSMEN
SURPLUS & REGULAR DRAFTING
DESIGN & DETAILING
ALL BRANCHES ENGINEERING
5 Beekman St. Worth 4-5073 N. Y. 7, N. Y.

HERMAN LEWIS GORDON
Registered Patent Attorney
Patent Investigations and Opinions
Warner Building 109 Normandy Drive
Washington 4, D. C. Silver Spring, Md.
National 2497 SHepherd 2438

METCUT RESEARCH ASSOCIATES
Consultation on Machining of Metals • Metallurgy
Cost and Production Analysis of Machining
Laboratory Testing of Machining Properties of Metals • Cutting Fluids • Cutting Tools
4229 Braze St. Cincinnati 9, Ohio Jefferson 7868

CHARLES VESELY & ASSOCIATES, INC.
Industrial Designers and Engineers
Design Consumers Products
Engineering Commercial Equipment
Product Development Durable Goods
197-N. 123rd Street, Wauwatosa 13, Wisconsin

SEARCHLIGHT SECTION

(Classified Advertising)

EMPLOYMENT : BUSINESS : **"OPPORTUNITIES"** : EQUIPMENT : USED OR RESALE

DESIGN AND PRODUCT ENGINEERS

Mechanical or Electrical Engineers having design or Product Engineering abilities will find an opportunity in one of the several positions now available with long established concern whose products have world-wide distribution. Experience with the design of precise, electro-mechanical elements is desirable. Location is in upstate New York. Please include full particulars as to experience and training with your reply.

P7811, Product Engineering
330 West 42 St., New York 18, N. Y.

TECHNICAL AND RESEARCH ENGINEER

Excellent opportunity for creative and research minded engineer with well established rubber company where his new ideas, inspirational and organisational qualifications will permit him to work with large group of technical and development engineers. This requires above average engineer. Age 30 to 40. Furnish complete information in first letter. Replies held in strict confidence.

P-7105, Product Engineering
520 North Michigan Ave., Chicago 11, Ill.

PRODUCT DESIGNER, SCULPTOR PREFERRED

Established manufacturer of commercial refrigerators and refrigerated display equipment wants to hire a full-time designer who is willing to submit to discipline of factory operations and who wants to learn a variety of techniques of sheet metal fabrication. Permanent position. Successful applicant might well eventually take over complete artistic responsibility for product development. In letter state age, starting salary, education, and positions previously held (if any). Try to furnish pictures showing artistic accomplishments.

KOCH REFRIGERATORS
North Kansas City, 16, Mo.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (18)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

EMPLOYMENT SERVICES

SALARIED POSITIONS $3,500-$35,000. If you are considering a new connection communicate with the undersigned. We offer the original personal employment service (28 years recognized standing and reputation). The procedure, of highest ethical standards, is individualized to your personal requirements and develops overtures without initiative on your part. Your identity covered and present position protected. Send only name and address for details. R. W. Bixby, Inc., 268 Dun Bldg., Buffalo 2, N. Y.

SALARIED PERSONNEL $3,000-$25,000. This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. H, 241 Orange St., New Haven, Conn.

POSITIONS WANTED

PATENT ATTORNEY 44 seeks connection with aggressive company in mechanical field. Over 18 years varied patent experience including preparations, prosecutions, patent and industrial surveys, investigations, negotiations, etc. Can set up new patent department if desired. PW-7464, Product Engineering.

NEW ADVERTISEMENTS

Copy must be received by February 17th to appear in the March issue.

Good opening for a competent Plant Manager

Our Company has opening for a Plant Manager, preferably one with mechanical engineering experience and actual plant management, including personnel and production work. Sales experience would likewise be desirable. Plant located in Northern Mississippi. Liberal compensation and permanent. Good opportunity for future advancement.

All replies held strictly confidential.
Address reply to Manufacturer,

P. O. Box 167,
Memphis 1, Tennessee

FILTER ENGINEER

Reputable Midwestern automotive equipment manufacturer has an excellent opportunity for a Filter Engineer to supervise laboratory and design filter elements. Give complete details in first letter.

P-7488, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

Exceptional Opening for SALES ENGINEER

to cover Mid-West Metalworking Industry

Selling Experience Desirable
But Not Essential

Nationally known manufacturer of fastening devices wants man to advise customers on applications—not take orders—working in mid-west with headquarters preferably in St. Louis or Kansas City. Salary to be commensurate with experience.

Requirements: Varied knowledge of metalworking production gained by plant work or selling; ability to travel extensively away from home. Write in detail about background. Interview arranged at New York headquarters; expenses paid.

RW 7272 Product Engineering
330 West 42nd St., New York 18, N. Y.

PRODUCTION ★ ★ ILLUSTRATION

MECHANICALS & VISUALS
CUTAWAYS & RENDERINGS
OF ALL TYPES
INQUIRIES INVITED

GW 7405 Product Engineering
330 West 42nd St., New York 18, N. Y.

ENGRAVING AND PROFILING

On All Metals and Plastics

Largest Production Facilities
Precision Work—Long and Short Runs
Instrument Panels—Dials—Nameplates
Send blueprints for quotation
PROMPT SERVICE

HERMES ENGRAVERS, INC.
11 University Place New York 3, N. Y.

ENGINEERS—

Rapidly expanding Engineering Department of North American Aviation, Inc., needs qualified

AERODYNAMICISTS
THERMODYNAMICISTS
STRESS ANALYSTS
AIRCRAFT DESIGNERS

and specialists in all phases of aircraft engineering, for work on military projects. Experience in fields other than aircraft engineering may be adaptable. Please include summary of experience in reply.

Engineering Personnel Office

NORTH AMERICAN AVIATION, INC.
Los Angeles Airport,
Los Angeles 45, Calif.

NEW PRODUCT *Available*

This is a truly high class non competitive low production cost sensational product with world wide sales possibilities. Invented by mechanical engineer with 22 years of experience. Plant required employing at least 200 people on hand and automatic screw machines, centerless and surface grinders, inspection and assembly.

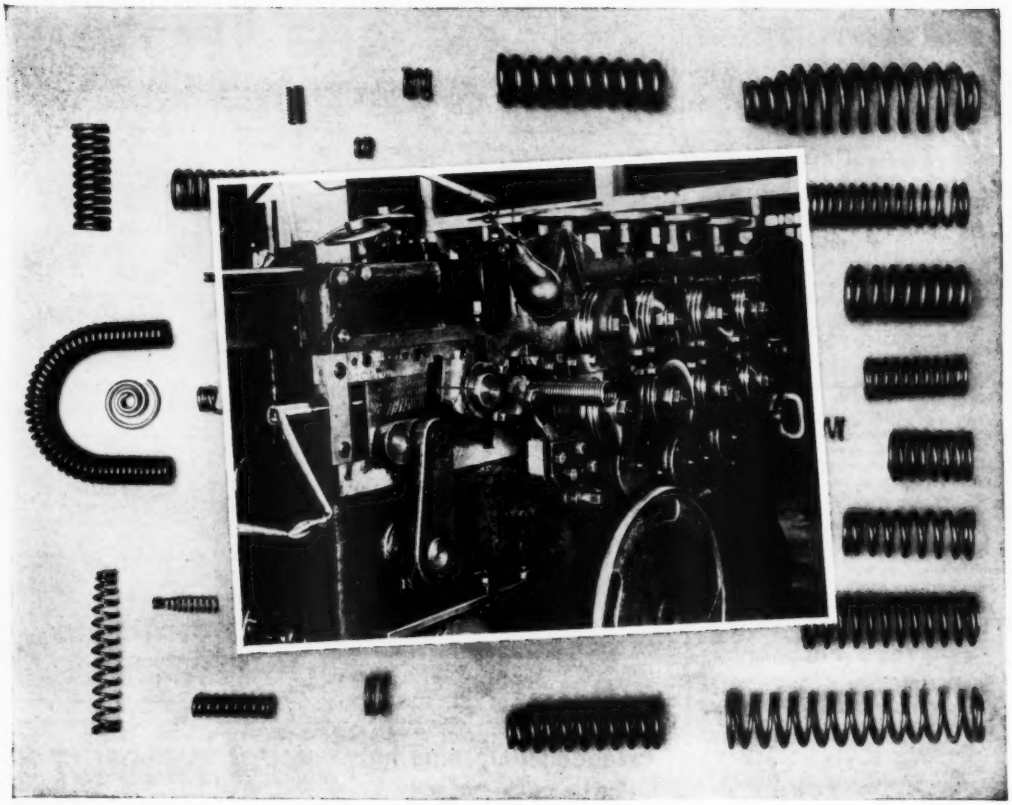
BO-7795, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

The Very Best Facilities For . . .

METAL STAMPINGS

IN SMALL LOTS

DAYTON ROGERS
Manufacturing Company
Minneapolis 7, Minn.



SPRINGS A-POPPIN'

EVERY DAY you'll find hundreds of thousands of Wickwire springs popping from scores of machines like these. They may be straight, tapered, cone-shaped; tiny enough for a cigarette lighter or big enough for an overhead garage door.

Operating these automatic coiling machines is no "feed-and-let-run" proposition. Meeting spring specifications calls for correct design, skillful toolmaking and precise adjustment of tools, cams and operating speeds. It takes experience to develop such skill . . . and many of Wickwire's spring specialists have been doing it for over 25 years. During this time they have engineered well over 50,000 different spring designs.

Our engineers are at your service in designing any conceivable type of wire spring or wire form. Why not write us? Also, let us send you our free book, "Springs and Formed Wires." It's full of valuable engineering data about spring selection and performance. Just address your request to Spring Dept., The Wickwire Spencer Steel Division of C. F. & I., 2 New Bond St., Worcester 6, Mass.

CF&I WICKWIRE SPENCER SPRINGS

A PRODUCT OF THE WICKWIRE SPENCER STEEL DIVISION • THE COLORADO FUEL AND IRON CORPORATION

SPRING SALES OFFICE & PLANT—2 New Bond St., Worcester 6, Mass. • **EXECUTIVE OFFICE**—500 Fifth Ave., N.Y. 18, N.Y.
SALES OFFICES—Boston•Buffalo•Chicago•Denver•New York•**PACIFIC COAST**—The California Wire Cloth Corp., Oakland 6, Cal.

Other quality Wickwire Spencer Products include: Wire, Wire Rope, Metal Conveyor Belts, Chain Link Fence, Industrial Wire Cloth, Poultry Netting, Hardware Cloth, Insect Wire Screening, Welded Wire Fabric for concrete reinforcement.

INDEX OF *Products Advertised* IN THIS ISSUE

MATERIALS

Aluminum Alloys ..16, 27, 32, 57, 189
Bimetal 337
Brass 8, 66–67, 242, 289
Bronze 66–67, 282, 346
Carbon 262
Copper Alloys 8, 66–67, 242 264, 325
Felt 263
Fibre 204
Friction Materials 154
Glass 274
Graphite.....4th Cover, 20–21
Laminated Metals 71
Leather 251
Magnesium Alloys 241, 253
Molybdenum Alloys 290
Nickel Alloys.....2nd Cover, 36, 44 66–67, 206
Nylon 234
Phospher Bronze 206
Plastics..32B, 37, 38, 53, 60, 234, 260 270, 275, 277–278, 290, 308, 331–332
Plastics, Laminated 233, 260
Resins 60
Rubber & Synthetics.....6, 180, 221 250, 255
Silicones 69, 184
Stainless Steel..36, 158, 197, 244, 261 269, 319
Steel 32A, 75, 160, 217, 230 305, 313
Wood 296
Zinc 325

STRUCTURAL PARTS

Castings.....62, 214, 218, 326, 334
Die Castings.....16, 55, 193, 291, 322
Forgings 207, 289, 319, 322, 324 330, 348
Rods 234, 242
Stampings 28, 205, 214, 322, 324
Tubing ..44, 72, 191, 195, 216, 225, 242 252, 265, 322
Wire.....50, 219, 242, 261

FINISHES

Galvanizing 288
Paints & Lacquers.....163, 274
Plating 173, 194
Polishing 194, 303
Rust Proofing 194, 281

MECHANICAL PARTS

Balls 182, 322
Bearings, Ball, Roller, and Needle 4th Cover, 52, 56, 61, 68, 73, 80, 192 212, 238, 280, 283, 288 298, 301, 315, 333
Bearings, Sleeve 247, 307, 346
Bellows 45, 46
Belts :.....49, 200–201, 255, 297
Bolts, Nuts, Screws and Rivets..14–15 30, 33, 34, 40–41, 57, 77, 165, 179, 186 190, 196, 208, 254, 257, 258, 262, 266 279, 286, 292, 308
Brushes 274
Chains 54, 200–201, 293, 344
Clamps 222
Clutches....63, 256, 293, 304, 320, 335
Controls 262, 306
Counters 17
Couplings, Flexible..186, 232, 239, 329
Couplings, Hose & Tube.....239, 329
Engines.....51, 222, 234, 246, 284
Fasteners.....14–15, 30, 33, 34, 40–41 57, 77, 165, 179, 186, 187, 190, 196 208, 254, 257, 258, 262, 266, 279, 286 292, 308
Filters 48, 65, 327
Gages & Instruments.....198, 249 286, 333
Gears..76, 196, 202, 232, 282, 285, 294 306, 320, 324, 326, 329, 330
Hose 323
Hydraulic & Pneumatic Equipment 178, 227, 236, 245, 262, 271 272, 293, 304, 314, 327
Joints 334
Lubricating Equipment ...47, 228, 321
Meters 320
Name Plates 295
Packing, Gaskets, Seals..4, 20–21, 43 47, 64, 221, 226, 231, 251, 263, 309
Plastic Machinery 227
Pumps....12–13, 49, 202, 204, 211, 224 271, 298, 330
Rings 64, 176, 203
Riveting Machines 314
Shafts 182, 316
Speed Reducers & Motor Reducers..39, 222, 232, 261, 333
Springs..58, 70, 194, 202, 292, 300, 342
Tanks 214
Testing Equipment 280, 299
Thermostats.....26, 45, 78, 337
Timers.....188, 198, 243, 286, 328
Tires 238
Tractors 284
Transmissions.....3rd Cover, 9, 12–13 39, 76, 171, 181, 211, 271, 293, 328
Universal Joints 318
Valves & Fittings....169, 211, 271, 298 300, 310, 314, 335
Vibration Dampers 299
Washers 187, 262
Wheels & Casters..... 190
Wire Cloth 230, 318

ELECTRICAL PARTS

Assemblies 302
Brakes 63
Contacts....2, 22, 59, 78, 174–175, 185 267, 268, 286
Controls & Control Equipment.. 2 10–11, 12–13, 22, 35, 59, 174–175, 177 185, 213, 240, 267, 268, 273, 286 311–312, 316, 326, 327, 339
Electronic Equipment 213
Generators 306
Heating Units 23, 204, 248
Instruments 333
Insulators 204, 220, 234
Lamps 338
Magneto 59
Motors..3rd Cover, 9, 12–13, 24–25, 39 42, 49, 64A, B, C, & D, 171, 181, 211 215, 223, 229, 237, 240, 243, 276 280 287, 306, 324, 339
Rectifiers 2, 22
Wire & Cable 156, 302, 318
Wiring Accessories 29, 338

DRAFTING ROOM EQUIPMENT AND SUPPLIES

18–19, 74, 198, 199, 300, 337

FABRICATING METHODS AND SERVICES

Assembling 32
Bending 167
Cutting 328
Drawing 32
Extruding 27, 254
Finishing 32
Forming 32, 167, 340
Grinding 245
Hardening 317
Molding..32B, 37, 38, 53, 60, 180, 227 234, 259, 260, 270, 275, 277–278, 290 308, 310, 331–332, 337
Shearing 334
Spinning 32
Stamping.....28, 32, 205, 214, 254, 324 334, 340
Welding.....183, 235, 282, 339, 340

ENGINEERING AND PRODUCTION SERVICES

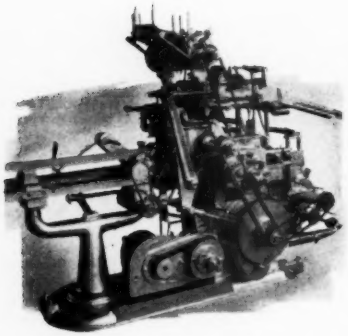
31, 290, 340, 348

BOOKS

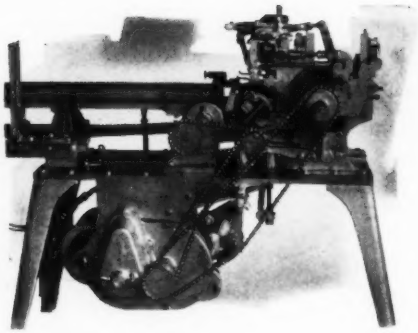
246, 316, 329

TRANSPORTATION

284



Packaging machine showing wide use of Diamond Roller Chain Drives. Multiple drives from one shaft can operate a multiple number of shafts.



Driven by Diamond Roller Chains, shafts can be operated in the same or opposite directions.

WHERE THERE ARE MANY SHAFTS TO DRIVE

Use Diamond Roller Chains

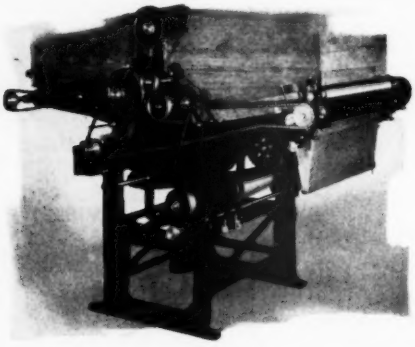
● Several shafts driven from one source at the same or different speeds — in the same or opposite directions, synchronizing the speed and operation of parallel mechanisms; all these are readily accomplished by the use of DIAMOND Roller Chains.

These precision chains are available for transfer of fractional horsepower or several thousand — for rotating speeds of 1 or 2 r.p.m. or 4000 r.p.m. They are identical on both sides to run under or over sprockets. Catalog 617 is available on request.

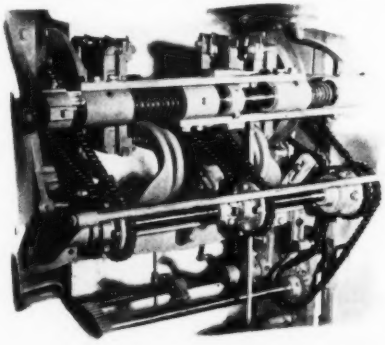
DIAMOND CHAIN COMPANY, Inc., Dept. 443, 402 Kentucky Avenue, Indianapolis 7, Indiana

Offices and Distributors in All Principal Cities

DIAMOND ROLLER CHAINS



This tobacco tamper achieves efficient operation through application of Diamond Roller Chains.



Automatic high-speed, box-making machine equipped with Diamond Chain Drives for economy and increased output.

ADVERTISERS INDEX

Accurate Spring Mfg. Co. 194
Advance Paint Co. 163
Ahlberg Bearing Co. 280
Aircraft-Marine Products Co. 185
Air Express Division of Railway Express Agency 284
All American Tool & Mfg. Co. 280
Allegheny Ludlum Steel Corp. 319
Allen Mfg. Co. 254
Alliance Mfg. Co. 280
Allied Research Products, Inc. 194
Allis-Chalmers Mfg. Co. 12-13, 49
Allis-Chalmers Mfg. Co. (Tractor Div.) 284
Allmetal Screw Products Co., Inc. 190
Aluminum Co. of America-Die Casting 16
Aluminum Co. of America-Fabricator 27
Aluminum Co. of America Fasteners 57
American Chain & Cable Co., Inc. 261, 306
American Felt Co. 263
American Hard Rubber Co. 180
American Hot Dip Galvanizers Assn. 288
American Magnesium Corp. 241
American Metal Hose Branch, American Brass Co. 323
American Nickeloid Co. 173
American Roller Bearing Co. 298
American Screw Co. 33, 77
Ampco Metal Inc. 282
Anaconda Sales Co. 325
Arkwright Finishing Co. 300
Armco Steel Corp. 158
Armstrong Cork Co. 43
Arrow-Hart & Hegeman Electric Co. 273
Arwood Precision Casting Corp. 334
Atlantic Steel Co. 322
Auburn Button Works, Inc. 270
Auto Engine Works 320
Automatic Electric Sales Corp. 267
Automotive & Aircraft Div. of Amer. Chain Co., Inc. 306

Babcock & Wilcox Tube Co. 252
Bakelite Corp. 331-332
Bantam Bearings Div. Torrington Co. 68
Barnes Co., Wallace, Div. Associated Spring Co. 70
Bath Co., Cyril 167
Beryllium Corp. 264
Bethlehem Steel Corp. 75
Bijur Lubricating Corp. 321
Boston Gear Works 329
Brady Products, Inc., F. E. 298
Bridgeport Brass Co. 66-67
Briggs & Stratton Corp. 246
Brown & Sharpe Mfg. Co. 249
Brown Instrument Company 268
Bruning Co., Inc., Charles 74
Bundy Tubing Co. 265
Bunting Brass & Bronze Co. 346

Cambridge Wire Cloth Co. 318
Camcar Products Co. 33
Carpenter Steel Co., Alloy Tube Div. 72
Cash Valve Mfg. Corp., A. W. 300
Catalin Corp. of America 60
Central Screw Co. 33
Century Electric Co. 276
Chace Co., W. M. 337
Chain Belt Co. 200-201
Chapman Valve Mfg. Co. 317
Chicago Rawhide Mfg. Co. 251
Cincinnati Metalcrafts, Inc. 31
Clifford Mfg. Co. 46
Climax Molybdenum Co. 290
Cold Metal Products Co. 269
Colorado Fuel & Iron Corp., Wickwire-Spencer Steel Div. 342
Commercial Shearing & Stamping Co. 334
Consolidated Molded Products, Inc. 259
Continental-Diamond Fibre Co. 233
Continental Rubber Works 250
Continental Screw Co. 33
Corbin Screw Div. of American Hdwe. Corp. 33
Coto-Coil Co., Inc. 302
Cramer Co., R. W. 286
Crane Company 169
Crocker Wheeler Electric Mfg. Co. 24-25
Cuno Engineering Corp. 65
Cuyahoga Spring Co. 300

Dayton Rogers Mfg. Co. 324
Dayton Rubber Manufacturing Co. 255
De Laval Steam Turbine Co. 330, 333
Delco Products Div., Gen. Mtrs. Corp. 215
Dial Light Co. of America 338
Diamond Chain Co., Inc. 344
Diefendorf Gear Corp. 330
Doehler-Jarvis Corp. 55
Dow Chemical Co. 253
Dow Corning Corp. 184
Driver-Harris Co. 213
DuPont de Nemours & Co., Inc., E. I., Neoprene 64
DuPont de Nemours & Co., Inc., E. I., Plastics 53
Durant Mfg. Co. 320
Durez Plastics & Chemicals, Inc. 38

Eagle Signal Corp. 328
Earle Gear & Machine Co. 306
Eastman Kodak Co. 199
Elastic Stop Nut Corp. of America 34
Elco Tool & Screw Corp. 33
Electric Auto-Lite Co. 32B, 156
Electric Specialty Co. 306
Electric Wheel Co. 190

Fairbanks-Morse Co. 171
Fawick Airflex Co. 256
Federal Bearings Co., Inc. 73
Federal Electric Products Co. 177
Federal-Mogul Corp. (Equipment) 246
Foote Bros. Gear & Machine Corp. 76
Ford Motor Co., Industrial & Marine Engine Sales Dept. 51
Fulmer Co., C. Allen 327
Fulton Sylphon Div. Robertshaw-Fulton Controls Co. 45

Gear Grinding Machine Co. 245
General Controls Co. 327
General Electric Co., Apparatus Dept. 10-11, 23, 35
General Electric Co., Appliance & Merchandise Dept. 29
General Electric Co., Chemical Dept., Silicones 69
General Industries, Inc. 240
General Plate Co. 71
General Tire & Rubber Co. 238
Gerity-Michigan Corp. 193
Gerotor May Corp. 236
Gibson Co., Wm. D. 58
Gits Bros. Mfg. Co. 228
Goodrich Chemical Co., B. F. (Hycar) 6
Grant Gear Works 222
Gray & Prior Machine Co. 318
Gray Iron Founders' Society Inc. 348
Great Lakes Steel Div., National Steel Corp. 160
Greene Mfg. Co., Inc. 337
Grigoleit Co. 308
Grinnell Co., Inc. 335

Hannifin Corporation 314
Hansen Mfg. Co. 239
Harper Co., H. M. 33
Hartford Special Machinery Co. 324
Hartford Steel Ball Co. 322
Hassall Inc., John 196
Haydon Mfg. Co. 198
Heyman Mfg. Co. 234
Hobbs Mfg. Co. 328
Holo-Krome Screw Corp. 208
Houghton & Co., E. F. 226
Howell Electric Motors Co. 237
Hussey & Co., C. G. 242
Hyatt Bearings Div., Gen. Mtrs. Corp. 52

Imperial Pencil Tracing Cloth 337
International Nickel Co., Inc. Monel 44
International Nickel Co., Inc. (Nickel Alloy) ..... 2nd Cover
International Rolling Mill Products Corp. 313
International Screw Co. .....
Interstate Mfg. Corp. 318

James Gear Mfg. Co., D. O. 232
Janette Mfg. Co. 327
Johns Manville Corp., Packing 309
Johnson Bronze Co. 307
Johnson Corp. 335
Jones & Laughlin Steel Corp. 305

Keuffel & Esser Co. 18-19
Kingston-Conley Electric Co. 324
Kinney Mfg. Co. 304
Koppers Co., Inc.-Plastics Div. 275

Laminated Shim Co., Inc. (Ancorlox) 308
Lamson & Sessions Co. 33, 257
Lebanon Steel Foundry Co. 62
Light Metals Corp. 254
Lincoln Electric Co. 183
Linde Air Products Co. 303
Linear, Inc. 231
Link-Belt Co. 9
Lisle Corp. 178
Littleford Bros., Inc. 282
Logansport Machine Co., Inc. 304
Lombard Governor Corp. 328

If precision is your problem, sleeve bearings will solve it to the fullest extent... In modern aircraft engines and their superchargers—on the spindles of precision machine tools—where precision is paramount—Bunting Cast Bronze sleeve bearings are used... Versatile in design and alloy, Bunting Bearings offer advantages which we would like to discuss with you. The Bunting Brass & Bronze Co., Toledo 9, Ohio. Branches in Principal Cities.

Bunting

BRONZE BEARINGS ☆ BUSHINGS ☆ PRECISION BRONZE BARS

42

ADVERTISERS INDEX

Lukens Steel Co. (Clad Steel)... 36
Lukens Steel Co. (Flanging & Pressing) 30

McGill Mfg. Co., Inc..... 301
McGraw-Hill Book Co., Inc...246, 316 329
MB Mfg. Co., Inc..... 299
Mahon Co., R. C..... 235
Makepeace Co., D. E..... 176
Mallory & Co., Inc., P. R....2, 22
Manheim Mfg. & Belting Co..... 297
Martin-Hubbard Corp..... 290
Masonite Corporation 296
Master Electric Co. Speedmaster 3rd Cover
Mercury Clutch Div., Automatic Steel Pdts., Inc..... 335
Metron Instrument Co..... 333
Meyercord Co. (Name Plate Div.) 295
Midwest Molding & Mfg. Co..... 310
Milford Rivet & Machine Co..... 33
Miniature Precision Bearings, Inc. 333
Minneapolis-Honeywell Regulator Co. 268, 339
Monsanto Chemical Co..... 37
Morganite, Inc. 310
Morse Chain Co..... 293
Mt. Vernon Die Casting Corp.... 291
Mueller Brass Co..... 289

National Lock Co..... 33
National Lock Washer Co. (Forgings) 330
National Lock Washer Co. (Kantlink) 187
National Motor Bearing Co., Inc. 47
National Screw & Mfg. Co..... 33
National Steel Corp..... 32A, 160
National Vulcanized Fibre Co.... 204
Neveroil Bearing Co..... 238
Newark Wire Cloth Co..... 230
New Departure Div. of Gen. Motors Corp. 80
New England Screw Co..... 33
Nice Ball Bearing Co..... 212
Nicholson & Co., W. H..... 339
Nikoh Tube Co..... 313
Norma-Hoffman Bearings Corp... 283

Ohio Gear Co..... 285
Ohio Precision Casting Co..... 326
Ohio Seamless Tube Co..... 225
Ohmite Manufacturing Co....311-312
Oilgear Co. 211
Owens-Corning Fiberglas Corp... 220

Packard Electric Div., General Motors 229
Page Steel & Wire Div., Amer. Chain & Cable Co., Inc..... 261
Parker-Kalon Corp. 33, 279
Parker Rust Proof Co..... 281
Pawtucket Screw Co..... 33
Peck Spring Co..... 292
Perkins Machine & Gear Co..... 294
Permanente Metals Corporation.. 189
Pesco Products Co.-Borg-Warner-Corp. 224
Pheoll Manufacturing Co..... 33
Phillips Screw Manufacturers... 33
Pittsburgh Plate Glass Co., Brush Div. 274
Powrex Switch Co..... 316
Precision Tube Co..... 191
Pressco Casting & Mfg. Co..... 322
Progressive Mfg. Co..... 286
Pure Carbon Co., Inc..... 262

Quaker Rubber Corp..... 221

R. B. M. Division of The Essex Wire Corp. 286
Raybestos-Manhattan Inc., Equipment Sales Division..... 154
Reading Screw Co..... 33
Redmond Co., Inc..... 42
Reed & Prince Mfg. Co..... 266
Reliable Spring & Wire Forms Co. 202
Reliance Electric & Engineering Co. 223
Revere Copper & Brass Inc..... 8
Reynolds Metals Co., Industrial Parts Div. 32
Reynolds Wire Co..... 50
Richardson Co. 260
Rockford Clutch Div., Borg-Warner 320
Rockford Screw Products Co..... 33
Roebling's Sons Co., John A..... 219
Roehr Products Co..... 322
Rollway Bearing Co., Inc..... 288
Rotary Seal Co..... 4
Russell, Burdsall & Ward Bolt & Nut Co. 33, 258

SKF Industries, Inc..... 315
Sandvik Steel, Inc..... 217
Schatz Mfg. Co..... 56
Scintilla Magneto Div., Bendix Aviation Corp. 59
Scovill Mfg. Co. Industrial Fasteners 179
Scovill Mfg. Co..... 33
Seaboard Screw Corp..... 33
Sewall Mfg. Co. E. B..... 196
Seymour Manufacturing Co..... 206
Shakeproof Inc..... 33, 40-41
Sharon Steel Corp..... 197
Sier Bath Gear & Pump Co..... 326
Skinner Electric Valve Div., The Skinner Chuck Co..... 298
Skinner Purifiers Div., Bendix Aviation Corp. 48
Smith Corp., Winfield H..... 261
Soreng Mfg. Corp..... 326
Southington Hardware Mfg. Co. 33
Spencer Thermostat Division Metals & Controls Corp. 26
Sperry Products, Inc..... 262
Standard Electric Time Co..... 188
Standard Locknut & Lockwasher Co. 262
Standard Pressed Steel Co...14-15, 292
Standard Tube Co..... 216
Steel Co. of Canada, Ltd..... 33
Stephens-Adamson Mfg. Co..... 197
Sterling Bolt Co..... 33
Sterling Electric Motors, Inc..... 287
Stewart Mfg. Corp., F. W..... 182
Stokes Machine Co., F. J..... 227
Stolper Steel Products Corp..... 214
Strom Steel Ball Co..... 182
Stronghold Screw Products, Inc. 33
Sundstrand Machine Tool Co... 271
Superior Steel Corp..... 244
Synthane Corp. 277–278

Telechron Inc. 243
Tempil Corp. 198
Thomas Flexible Coupling Co.... 186
Thomas Steel Co..... 230
Timken Roller Bearing Co..... 61
Torrington Co. 340
Torrington Co., Bantam Bearings Div. 68
Tourek Mfg. Co., J. J..... 334
Transue & Williams Co., (Stamping Div.) 205
Tuthill Pump Co..... 204

Uebelhoer Brothers, Inc..... 234
Union Carbide & Carbon Corp. 303 331-332
Unitcast Corp. 214
United-Carr Fastener Corp..... 186
United Screw & Bolt Corp..... 165
U. S. Graphite Co. 4th Cover, 20-21

Veeder Root, Inc..... 17
Vickers Inc. 272
Viking Pump Co..... 202
Vulcan Electric Co..... 204

Wagner Electric Corp..... 181
Waldes-Kohinoor, Inc. 203
Wales-Beech Corp..... 33
Ward Leonard Electric Co. 174-175
Warner Electric Brake Mfg. Co... 63
Watertown Mfg. Co..... 290
Watson-Flagg Machine Co..... 202
Weirton Steel Co..... 32A
Welco Motors 339
Wesche Electric Co., B. A..... 339
Westinghouse Electric Corp..... 39 64A, B, C & D
Wheland Co. 218
White Dental Mfg. Co., S. S. 234, 316
Whitney Chain & Mfg. Co..... 54
Wiegand Co., E. L..... 248
Williams Co., J. H..... 324
Wilson Co., H. A..... 78
Wisconsin Motor Corp..... 222
Wittek Mfg. Co..... 222
Wolverine Bolt Co..... 33
Wolverine Tube Div., Calumet & Hecla Cons. Copper Co..... 195
Worcester Pressed Steel Co..... 28
Wyman-Gordon Co. 207

■

PROFESSIONAL SERVICES..... 340

■

SEARCHLIGHT SECTION
(Classified Advertising)

EMPLOYMENT
Positions Vacant..... 341
Selling Opportunities Offered..... 341
Positions Wanted..... 341
Employment Services..... 341
SPECIAL SERVICES
Contract Work..... 341
BUSINESS OPPORTUNITIES
Offered 341

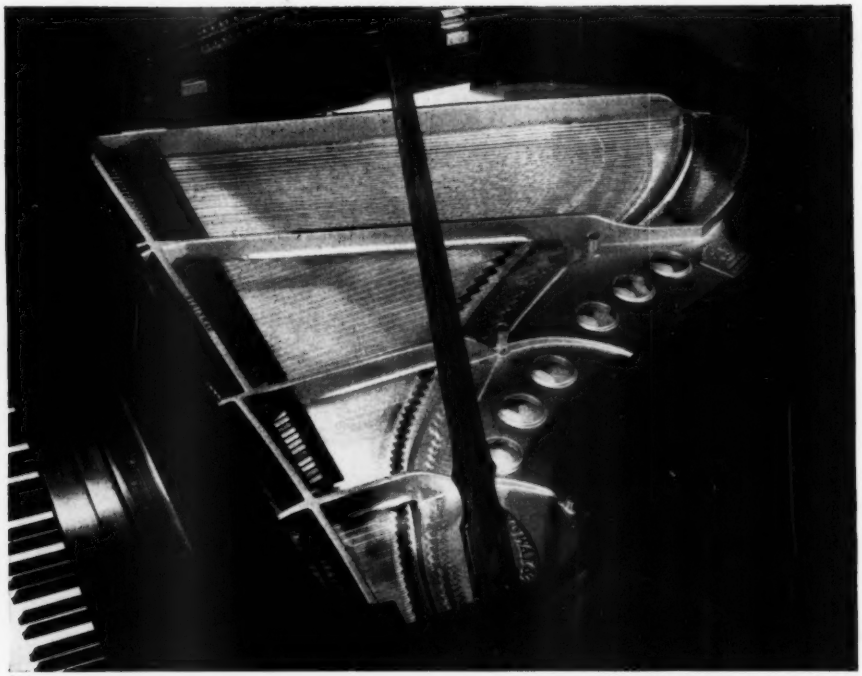


Photo of the Steinway by Victor Keppler

What Does a Piano Plate Need?

The purpose of a piano is to make music. To achieve that purpose successfully, it must be true to tone . . . it must hold pitch. The pull of the strings in a concert grand piano may be as great as 20 tons. In the plate which holds the strings, therefore, rigidity is essential.

Rigidity is one of the outstanding characteristics of Gray Iron. It also has a low coefficient of thermal expansion. That is why fine pianos are built with plates of Gray Iron. This quality of rigidity, combined with its many other attributes, makes gray iron the best material for thousands of products, from huge machine tools to delicate instrument parts.

Write for free booklet, "GRAY IRON—Its Mechanical and Engineering Characteristics, and Details for Designing Cast Components".

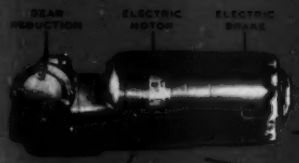
Gray Iron Characteristics Include:

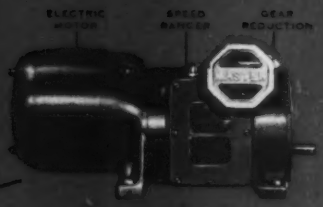
Castability	Corrosion Resistance
RIGIDITY	Machinability
Low Notch Sensitivity	Vibration Absorption
Wear Resistance	Durability
Heat Resistance	Wide Strength Range

Make It Better With Gray Iron

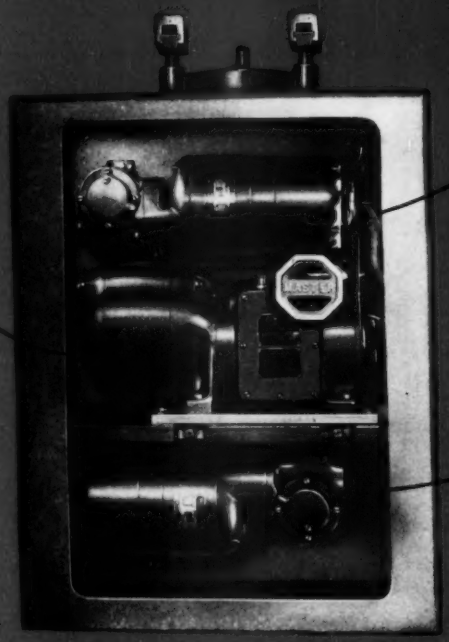
GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY BANK BLDG., CLEVELAND 14, OHIO





Easy does it



Don't put up with make-shift assemblies when it is so easy to get the RIGHT horsepower, the RIGHT shaft speed, the RIGHT construction features, the RIGHT mounting . . . all combined into one compact power package.

Master Motors, available in millions on millions of combinations of types and ratings, permit you to use a power drive on each job that's just right . . . a power drive that will add greatly to the compactness, appearance, and economy of each of your applications.

Use Master Motors to increase the salability of your motor-driven products . . . improve the economy and productivity of your plant equipment. They're the horsesense way to use horsepower.

THE MASTER ELECTRIC COMPANY
DAYTON 1, OHIO

The almost uncanny efficiency and complete dependability of today's adding machine is a triumph of American ingenuity — and the result of sound engineering and design. The whirling gears and shafts and the lightning-like piston strokes that give accurate totals with amazing speed *are kept true and trouble free* in many of the popular makes, *with the help of Gramix bearings.* In the machine shown, six Gramix powdered-metal bearings — five bronze and one iron — perform faultlessly. Gramix bearings are die-pressed powdered metals that *require no costly machining and finishing.* Gramix parts are porous — retaining lubricant and releasing it only as required. They are tough and strong and operate with a minimum of noise and wear. Gramix gears, bearings, bushings and other machine parts may help you solve a production problem and save you money. Send us your prints for specific recommendations. *Ask for your copy of the 264-page Gramix catalog.*

GRAMIX

THE UNITED STATES GRAPHITE COMPANY • SAGINAW, MICHIGAN

DIVISION OF THE WICKES CORPORATION